THE WELFARE VALUE OF INLAND SMALL-SCALE FLOODPLAIN FISHERIES OF THE ZAMBEZI RIVER BASIN

BY

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To my family:

Maness, Moses, Grace… I salute you all for your endurance, encouragement and support.

DECLARATION

I hereby declare that this thesis is my own work and effort and that it has not been submitted anywhere else for any award. Where other sources of information have been used, they have been duly acknowledged.

Signed by candidate

……………………………..

Peter Gilbert Ngoma

"Most of the people in the world are poor, so if we knew the economics of being poor we would know much of the economics that really matters."

T.W. Schultz (1980)

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LIST OF ACRONYMS

BMZ	:	German Federal Ministry for Economic Cooperation and Development
BVC	:	Beach Village Committee
CBZ	:	Central Bank of Zambia
CDCs	:	Chronically Deprived Countries
CEH	:	Centre for Ecology and Hydrology
CI	:	Confidence Interval
CPI	:	Consumer Price Index
CPRC	:	Chronic Poverty Research Center
CPRs	:	Common Property Resources
CSO	:	Central Statistical Office
DAC	:	Development Assistance Committee
DFID	:	Department for International Development
DoF	:	Department of Fisheries
EPA	:	Agricultural Extension Area
ESCOM	:	Electricity Supply Commission of Malawi
FAO	:	Food and Agriculture Organisation
FFSSA	:	Forum for Food Security in Southern Africa
FGT	:	Foster, Greer and Thorbecke
GDP	:	Gross Domestic Product
GMA	:	Game Management Area
GoM	:	Government of Malawi
IFAD	:	International Fund for Agricultural Development
IFPRI	:	International Food Policy Research Institute
JICA	:	Japan International Cooperation Agency
MDGs	:	Millennium Development Goals
MoAC	:	Ministry of Agriculture and Cooperatives
MoAFS	:	Ministry of Agriculture and Food Security
NCDC	:	National Climatic Data Center
NGO	:	Non Governmental Organisation
NP	:	National Park
NSO	:	National Statistical Office
ODI	:	Overseas Development Institute

OECD	:	Organisation for Economic Cooperation and Development
OLS	:	Ordinary Least Squares
PPP	:	Purchasing Power Parity
RBM	:	Reserve Bank of Malawi
RoZ	:	Republic of Zambia
SD	:	Standard Deviation
SE	:	Standard Error
SLA	:	Sustainable Livelihood Approach
SPSS	:	Statistical Package for Social Scientists
SPV	:	Social Protection Value
TEV	:	Total Economic Value
UN	:	United Nations
UNDP	:	United Nations Development Programme
UNGA	:	United Nations General Assembly
USAID	:	United States Agency for International Development
WFC	:	WorldFish Center
WFP	:	World Food Programme
WMO	:	World Meteorological Organisation
WWF	:	WorldWide Fund
ZAWA	:	Zambia Wildlife Authority
ZESCO	:	Zambia Electricity Supply Corporation
ZRA	:	Zambezi River Authority
ZRB	:	Zambezi River Basin

CURRENCIES AND SYMBOLS

UNITS

cm	:	centimetre
ha	:	hectare
kg	:	kilogramme
km	:	kilometre
m	:	metre
mm	:	millimetre

CURRENCIES

MK	:	Malawi Kwacha
US$	:	United States Dollars
ZMK	:	Zambia Kwacha

SYMBOLS

#	:	number
%	:	per cent
°	:	degrees
'	:	minutes
°C	:	Degrees Celsius

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ABSTRACT

The study assessed the welfare value of fisheries in reducing income poverty and economic vulnerability in the Kafue and the Lower Shire floodplains under the hypothesis that inland small-scale floodplain fisheries significantly reduce poverty and vulnerability in fishing households. The welfare value was also analysed in the context of management regimes of the two floodplain fisheries. The relationship between inter-annual fish production, agricultural production and local rainfall was also evaluated.

The Kafue floodplain is situated between 15°20'-15°55'S and 26°-28°E and covers about 6,500 km^2 in the Southern Province of Zambia. Rainfall ranges from 600 mm to 780 mm and temperature ranges from 25°C to 35°C. Fish production ranged from 3,600 tons to 9,600 tons between 1980 and 2000. The department of fisheries regulates mesh size, closed season and gear licensing but enforcement is weak and is not supported by co-management. The floodplain has about 1.1 million people who undertake livestock, fishing, farming production and other off-farm activities.

The Lower Shire floodplain covers an area of about 6,700 km^2 and is located between 14°25'-17°50'S and 35°15'-35°20'E. The Shire River is the only outlet of Lake Malawi and drains into the Zambezi River. Rainfall ranges from 560 mm to 960 mm per annum and temperature ranges from 25°C to 33°C. The Lower Shire floodplain has a population of about 677,000 people who undertake a number of livelihood strategies mainly farming, fishing and livestock rearing. Fish production ranged from 1,400 tons to 3,000 tons between 1991 and 2005. Local institutions have informal mechanisms that restrict entry into the fishery. The department of fisheries conducts gear licensing and mesh size restriction and is supported by co-management arrangement. Enforcement of fisheries regulations is therefore strong in Lower Shire floodplain.

Data collection involved literature reviews, key informant interviews, focus group discussions and household surveys. Household surveys were conducted from June, 2007 to July, 2008 in the Kafue floodplain and from January to December, 2008 in the Lower Shire floodplain. Households were randomly sampled every month in both floodplains. A total of 891 and 1,044 households were used in the Kafue and the Lower Shire floodplain, respectively. Households were grouped based on labour allocation to fishing activities as

specialised farmers, fishing-farmers, farming-fishers and specialised fishers on a scale of 0 to 100 per cent time allocation to fishing, respectively. The data collection modules were informed by the livelihoods framework in which poverty and vulnerability analyses were performed. National poverty lines were estimated using 2005 international purchasing power parity poverty line after controlling for inflation in household income. Data analysis involved descriptive statistics, regression analysis, poverty and vulnerability indices and social protection value. Income poverty and economic vulnerability analysis included with and without fishing income scenarios.

In the Kafue floodplain, participation in fishing was mainly associated with immigrant status ($p < 0.05$), smaller land holding size ($p < 0.001$), lower livestock income ($p < 0.01$) and higher levels of household labour ($p < 0.001$) while the amount of time spent fishing increased with smaller land holding size ($p < 0.001$), fewer cattle owned ($p < 0.05$) and higher levels of household labour ($p < 0.001$). In the Lower Shire floodplain, participation in fishing was mainly associated with smaller land holding size ($p < 0.001$), higher levels of labour from male household members ($p < 0.001$) and higher off-farm income ($p < 0.01$) while the amount of time spent fishing increased with larger household sizes ($p < 0.01$), more labour from male household members ($p < 0.001$) and higher off-farm income ($p < 0.01$).

In the Kafue floodplain, fishing contributed about 50 per cent to total household income per month while it contributed about 15 per cent in the Lower Shire floodplain. Fishing contributed about 56 and 60 per cent to animal protein per month in the Kafue and Lower Shire floodplains, respectively. As a result of fishing income in fishing households, poverty head count decreased by 6 per cent ($p < 0.001$) and economic vulnerability decreased by 52 per cent ($p < 0.001$) in the Kafue floodplain while poverty head count decreased by 6 per cent ($p < 0.05$) and economic vulnerability decreased by 4 per cent ($p < 0.05$) in the Lower Shire floodplain. Both income poverty and economic vulnerability in fishing households were however higher in the Kafue floodplain than in the Lower Shire floodplain either with or without fishing income. In both floodplains, fishing income contributed substantially to social protection, equivalent to over 50 per cent of the minimum national daily wage rate.

In both floodplains, fish production had insignificant positive correlation with local rainfall variability with downward trend in years of above as well as below average rainfall while maize production had significant positive correlation with local rainfall variability ($p < 0.05$).

In the Kafue floodplain, fish production had a significant positive correlation with maize production ($p < 0.01$) while it had a significant negative correlation with maize production in the Lower Shire floodplain ($p < 0.05$).

The study found that fishing was undertaken by land constrained households in both floodplains. In addition, livestock production was higher while farming production was lower in the Kafue floodplain than in the Lower Shire floodplain. Livestock production is mainly undertaken by local residents who are pastoralists while immigrants are mainly involved in fishing in the Kafue floodplain. Most fishing households in the Kafue floodplain rely on fishing as the main source of income while most households in the Lower Shire floodplain rely on farming as the main source of income. In both floodplains, fishing is the main source of animal protein consumption.

Fishing households in the Kafue floodplain were poorer but less vulnerable than specialised farming households while fishing households in the Lower Shire floodplain were better-off and less vulnerable than specialised farming households. The Kafue floodplain fishing communities are further trapped in other dimensions of poverty including poor education, health and sanitation facilities; marginalization and poor road infrastructure while the Lower Shire floodplain fishing communities have a diverse base of livelihood strategies in which fishing has a smoothing effect on seasonal shortfalls in farming income.

Fishing effectively performs a safety net function in the Kafue floodplain for disenfranchised households that have immigrated into the area due to its open access and weaker management regime while it performs a risk spreading function in the Lower Shire floodplain among comparatively well-off households in asset holding and where access is restricted through informal mechanisms and stronger management regime.

The study found that in the event of poor local rainfall, fisheries provide a fall-back livelihood strategy to poor households. However, declining fish production threatens the sustainability of welfare function performed by the floodplain fisheries.

CHAPTER ONE: GENERAL INTRODUCTION

1.1 THE ZAMBEZI RIVER BASIN

The study was part of a collaborative research project on *"Food security and poverty alleviation through improved valuation and governance of river fisheries in Africa"* funded by the German Federal Ministry for Economic Cooperation and Development (BMZ) and coordinated by the WorldFish Centre (WFC). The project was implemented in the Zambezi River Basin (ZRB) and Lake Chad Basin. In the ZRB, the project sites were in the Kafue floodplain in Zambia and the Lower Shire floodplain in Malawi (Figure 1.1). This study was carried in ZRB with the goal of understanding the welfare value of the small-scale fisheries to the communities in the rural areas.

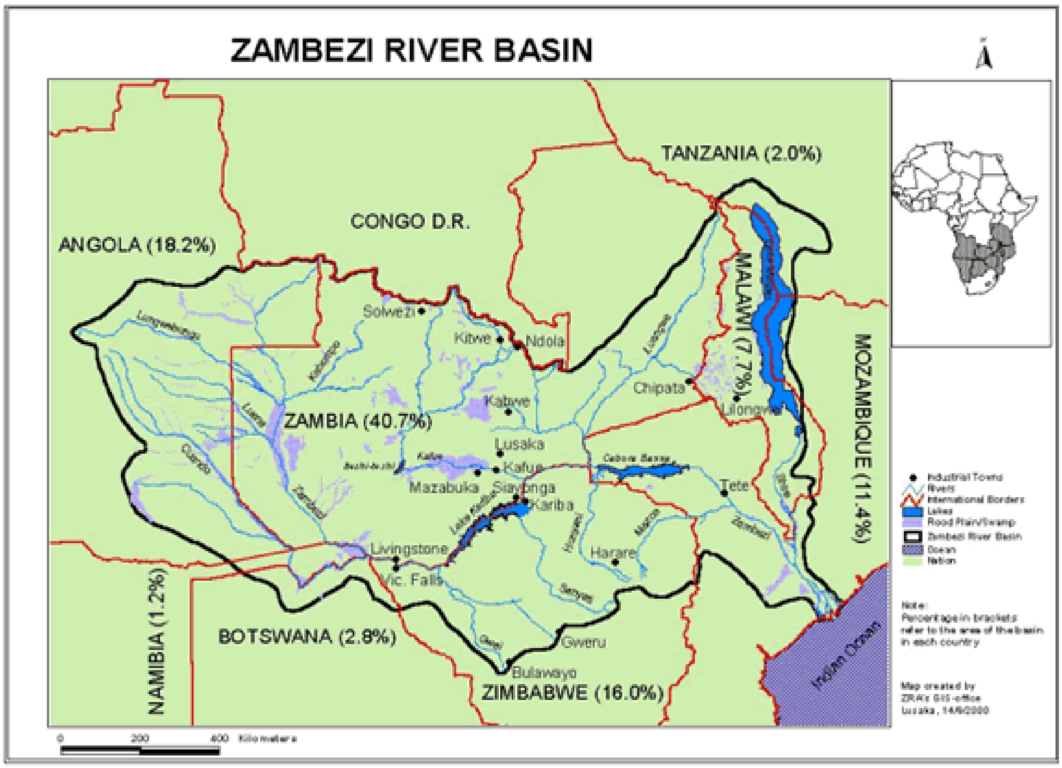

Figure 1.1: Map of the Zambezi River Basin showing major rivers including the case studies of the Kafue and Shire Rivers in Zambia and Malawi, respectively.

Source: ZRA, accessed from http://www.zaraho.org.zm/basin.html# in September 2009.

1.2 POVERTY AND RURAL DEVELOPMENT

Poverty remains a key challenge of the 21st century to rural development. For decades, poverty has been associated with low income and consumption. Of late, poverty has been recognised to encompass different dimensions of deprivation that relate to human capabilities which include income, consumption, food security, health, education, rights, voice, security, dignity and decent work (OECD 2001). It is now quite clear that poverty not only manifests as low income and consumption but also as human suffering, as vulnerability, as a basic needs failure, as the abrogation of human rights or even as degraded citizenship (CPRC 2009). The multidimensionality of poverty has had influence on some of the rural development approaches such as the Sustainable Livelihood Approach (SLA) currently used by many international non-governmental organisations (NGOs) and development agencies (Carney 1999). Even global frameworks for poverty reduction such as the United Nations General Assembly (UNGA) Declaration on Millennium Development Goals (MDGs) have also embraced the broader understanding of poverty (UNGA 2000). It is also evident from country specific poverty reduction strategies that aim at achieving the MDGs, for instance, the Fifth National Development Plan of the Republic of Zambia (RoZ) (UNDP Zambia 2007) and the Government of Malawi (GoM) Growth and Development Strategy (GoM 2008) were both formulated based on the understanding that poverty means more than just low income and consumption.

Despite a seemingly improved understanding of poverty in recent times, poverty reduction and rural development remain elusive in most parts of the developing world, particularly in Africa. A report by the United Nations Development Programme (UNDP) noted that poverty incidence in Africa today is almost the same as in 1990, signifying a protracted period of economic stagnation (UNDP 2005). Also, the International Fund for Agricultural Development (IFAD) observed that in Africa, extreme poverty is a largely rural phenomenon, with about 73 per cent of the poor living in rural areas (IFAD 2001). A current analysis by the Chronic Poverty Research Center (CPRC) found that about 53 per cent of the chronically deprived countries (CDCs)[1] in the world were in sub-Saharan Africa, which includes Malawi and Zambia (CPRC 2009). In both Malawi and Zambia, a report by Forum for Food Security in Southern Africa (FFSSA) indicated that meaningful developmental changes that ensure sustainable and equitable improvements in the quality of life for most members of society, and particularly, for the populous rural areas, are still lacking (FFSSA 2004). For instance, the incidence of rural poverty in 2005 in Malawi was 56 per cent (NSO Malawi 2005) while

[1] CDCs are characterised by relatively low initial levels of welfare such as relatively low GDP per capita, relatively high mortality, fertility and undernourishment and by relatively slow rates of progress across all available welfare indicators (Anderson 2007).

it was as much as 83 per cent in rural Zambia in 1998 (CSO Zambia 2000). Some of the rural population in both Malawi and Zambia include inland small-scale fishing communities living in the vicinities of the Zambezi River Basin (ZRB) floodplains, reservoirs, rivers, ponds and wetlands whose plight has largely been marginalised in poverty reduction and rural development efforts (WFC 2004).

1.3 POVERTY AND INLAND SMALL-SCALE FISHERIES

Recent estimates by WorldFish Center (WFC) suggest that there are about 56 million people directly involved in inland *small-scale fisheries*[2] in the developing world undertaking fishing and related post-harvest activities such as fish processing and fish trading (WFC 2009 in press). Inland small-scale fisheries have been reported to make significant contribution to the livelihoods of the rural fishing communities in terms of income, employment and nutritional security (WFC 2008, Baran *et al*. 2007, Bennett and Thorpe 2003, Chong *et al*. 2003, Neiland and Béné 2003, Turpie 2003, LaFranchi 1996). However, fishing communities have been associated with poverty for years to the extent that small-scale fishers are considered the poorest of the poor (Béné *et al*. 2003). For the past decade or so, there have been statements in most fisheries literature asserting that 'fishermen are the poorest of the poor' and 'fishing is the activity of last resort' (Pauly 1997), although these statements are currently being questioned (see Béné 2009, Allison and Horemans 2006, Allison *et al*. 2006). The current understanding on the multidimensional nature of poverty points to the fact that the nature of poverty in fishing communities is not specific to fishing areas *per se* but a general lack of economic, political and institutional development that affects the rural areas in which the

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[2] The Food and Agriculture Organisation (FAO) Working Group on Small-Scale Fisheries described small-scale fisheries as broadly characterized as a dynamic and evolving sector employing labour intensive harvesting, processing and distribution technologies to exploit marine and inland water fishery resources. The activities are conducted fulltime or part-time, or just seasonally, often targeted on supplying fish and fishery products to local and domestic markets, and for subsistence consumption. Export-oriented production, however, has increased during the last one to two decades because of greater market integration and globalization. While typically men are engaged in fishing and women in fish processing and marketing, women are also known to engage in near shore harvesting activities and men are known to engage in fish marketing and distribution. Other ancillary activities such as net-making, boatbuilding, engine repair and maintenance, etc. provide additional fishery-related employment and income opportunities to fishing communities. Small-scale fisheries operate at widely differing organizational levels ranging from self-employed single operators through informal microenterprises to formal sector businesses. This subsector, therefore, is not homogenous within and across countries and regions and attention to this fact is warranted when formulating strategies and policies for enhancing its contribution to food security and poverty alleviation (FAO 2004).

fishing communities live (Béné 2006). It is clear that there is currently little understanding on relative poverty in small-scale fishing communities as compared to other parts or groups of the population in which fishing communities are found (FAO 2006). Even within fishing communities, especially in inland small-scale fisheries, very little is known on the contribution of fishing to poverty alleviation (Béné 2006).

1.4 VULNERABILITY AND INLAND SMALL-SCALE FISHERIES

In most developing countries, where both human and institutional capacities to address inherent uncertainty of fishing activity are lower, it is often stated that fishing-related communities are probably among the most vulnerable socioeconomic groups, hence, fishing activity may be seen as a source of vulnerability, where vulnerability becomes a cause of poverty (Béné 2006). Vulnerability is defined as the likelihood that at a given time in the future, an individual, a household or a community will fall into or continue to experience poverty (CPRC 2009, Hoddinott and Quisumbing 2003). It results from the presence of hazards and stresses that threaten basic living standards and the actions and buffers deployed by those affected or likely to be affected (CPRC 2009). In the economic arena, these are generally referred to as risks and uncertainties which are stochastic events with known and unknown probability distributions, respectively (Devereux 2001, Siegel and Alwang 1999).

Although vulnerability is by no means identical to poverty, it is being recognized as a central element of poverty (Prowse 2003). In the absence of risks or shocks and therefore no vulnerability, poverty can still persist (Hoogeveen *et al.* 2006). Baulch and Hoddinott (2000) observed that the poverty problem is often one involving a large turnover of vulnerable people rather than a large core group of chronically poor. Thus, some researchers have started suggesting that fishing communities may not necessarily be worse off in the sense of income-poverty but may suffer from higher vulnerability that render them more prone to poverty (Béné 2009, Béné *et al*. 2003). However, in most inland small-scale fishing communities in the developing countries, predominantly in sub-Saharan Africa, very little information exists to demonstrate such incidences (WFC 2008, FAO 2005, WFC 2004).

1.5 WELFARE VALUE OF INLAND SMALL-SCALE FISHERIES

The relatively easy access to common-property resources (CPRs) such as inland small-scale fisheries (including others such as forests, wetlands, grasslands etc.) offer poor people the opportunity to extract/harvest the goods and services from the CPRs needed to sustain their livelihoods (Béné 2006). The ability of inland small-scale fisheries (and other CPRs) to support the livelihoods of mostly poor and marginalised households sometimes with limited access to land and other resources reflects the *welfare*[3] value of inland small-scale fisheries which can be related to the concept of *social protection*[4] (Table 1.1).

Table 1.1: Welfare mechanisms in inland small-scale fisheries

Social protection dimension	Type of household	Type of strategy	Role of small-scale fisheries (CPRs)
Social insurance	*Poor households*: unable to maintain a minimum living standard	*Ex-ante strategy*: against long term (chronic) poverty	*Last resort activity/ Labour safety value:* fisheries absorbs poor rural unskilled labourers
	Vulnerable households: at higher exposure to risks	*Ex-ante strategy:* against long term vulnerability	*Risk spreading:* fisheries provides a cushion or coping against risks
Social assistance	*Poor and vulnerable households*: may or may not be below the "poverty line"	*Ex-post strategy:* reaction against transient poverty or shocks	*Safety-net:* fisheries provides a fall-back in case of shocks

Source: Author's tabulation and modification from (Béné 2006).

The Overseas Development Institute (ODI) distinguishes two general kinds of action for social protection: social insurance and social assistance (ODI 2001). Other forms of social protection such as those outlined by Asian Development Bank (Ortiz 2002) are equally important but are not considered in this study. Social insurance involves regular premiums to secure entitlements to financial assistance in the occurrence of specified risks (CPRC 2009).

In the case of inland small-scale fisheries, these regular premiums can be construed as regular cash from fishing activity that poor, unskilled labourers with low or no education earn in order to maintain a minimum living standard against long term poverty. In this way, inland small-scale fisheries act as a 'last resort activity' or 'labour safety valve (buffer)' by

[3] Economic assistance to individuals, households or communities to improve their well-being.

[4] A form of support by public, private and/or not-for profit organisation to individuals, households or communities in their efforts to prevent, manage or overcome vulnerability and poverty (adapted and modified from CPRC 2009).

absorbing unskilled labourers and providing them with a minimum living standard. The inland small-scale fisheries resource can also provide vulnerable households the security to entitlements for financial assistance against long term vulnerability thereby performing a risk spreading role (Table 1.1). On the other hand, social assistance addresses poverty and vulnerability directly through transfers, in cash or in kind to poor households (Chen and Barrientos 2006). In the absence of or with limited public social protection, which is characteristic of most developing countries (CPRC 2009), inland small-scale fisheries may be construed to provide a *safety-net*[5] or a 'fall-back' strategy to poor and vulnerable households faced with transient poverty or shocks in the sense of social assistance (Table 1.1).

In low income countries like Malawi and Zambia, access to common property resources such as inland floodplain fisheries is a crucial element of the livelihood strategies of the rural poor (ODI 2001). Inland small-scale fishing may be the immediate social protection mechanism to smooth consumption and income and as a fall-back strategy in situation of crop failure, livestock disease outbreaks and job loss (Neiland and Béné 2008, WFC 2005, Turpie *et al*. 1999). Generally, these welfare functions from natural resources are still very obscure and rarely adequately valued and documented, particularly in tropical Africa (WFC 2008, Turpie 2003). Further, the role of small-scale floodplain fisheries as an activity of last resort or a risk spreading strategy has not been adequately investigated in the study areas. There is also no information relating the role of small-scale floodplain fisheries to social protection mechanisms in the study areas.

1.6 THE FISHERIES MANAGEMENT OBJECTIVE DILEMMA

A large proportion of fish stocks around the world, including those targeted by small-scale fisheries in developing countries, are either fully exploited or overexploited (FAO 2005). As a result, income, employment and nutritional benefits are already being lost and failure to introduce effective management systems will almost inevitably lead to further losses of benefits and make recovery all the more problematic. Article 7.1.1 of the Code of Conduct of the FAO Technical Guidelines for Responsible Fisheries (in FAO 2005) declared that:

[5] A form of cash transfer seeking to prevent poor or vulnerable individuals, households or communities from falling below a predetermined poverty threshold.

"States and all those engaged in fisheries management should, through an appropriate policy, legal and institutional framework, adopt measures for the long-term conservation and sustainable use of fisheries resources. Conservation and management measures should be based on the ***best scientific evidence*** *available and be designed to ensure the long-term sustainability of the fishery resources at levels which promote the objective of their optimum utilization and maintain their availability for present and future generations; short-term consideration should not compromise these objectives."*

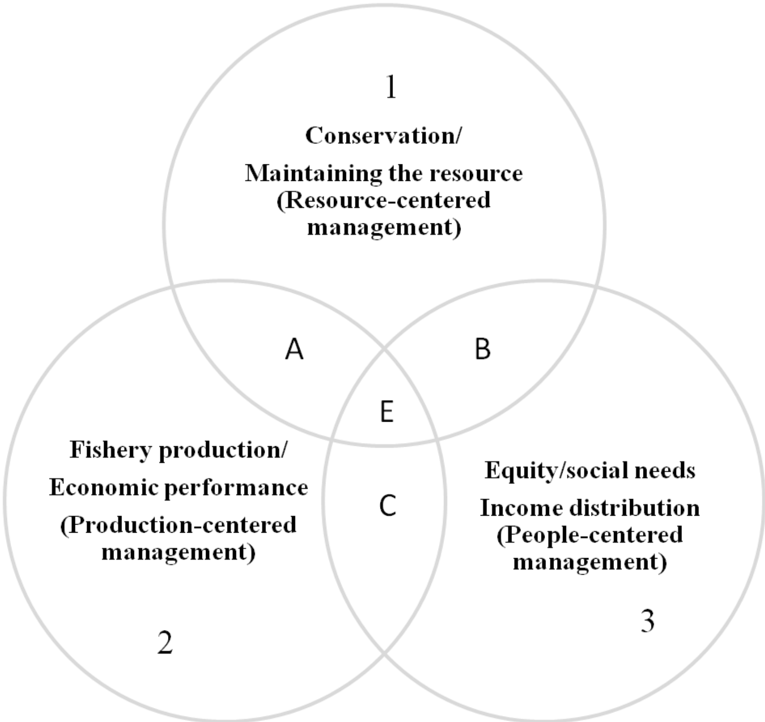

Figure 1.2: Competing fisheries management objectives

The quoted Code of Conduct implies that fisheries management is about mediating the interaction between people and resources involving a complex and varied sets of tasks aimed, ultimately, at ensuring that optimal benefits accrue from the use of the fisheries resource (FAO 2005). Often times, fisheries managers frequently face difficult dilemmas when attempting to encourage implementation of a particular measure against another as espoused in article 7.1.1. Fisheries managers must make decisions based on whether the overriding management objective is to conserve the fisheries resource, maximise harvest of the fisheries stock or promote equitable distribution of the fisheries resource as portrayed by Figure 1.2. The decision makers are called upon to weigh up opposing sets of issues and assess the degree of risk involved in the decisions they make. Good scientific evidence is therefore necessary to help fisheries managers make informed decisions regarding trade-offs between these competing objectives both in the short-term and long-term (FAO 2005). Such scientific evidence, particularly in relation to poverty and vulnerability of the fishing communities, is lacking in many sub-Saharan Africa inland small-scale fisheries, including those in the Zambezi River Basin (WFC 2004).

1.7 LOCAL RAINFALL, FISHERIES AND AGRICULTURAL PRODUCTION

Rainfall is one of the important factors affecting fish production in floodplain fisheries (Lowe-McConnell 1979, Henderson and Welcomme 1974, Ryder *et al.* 1974) and in sub-Saharan Africa, both fisheries and agricultural production are highly dependent on rainfall, with years of droughts strongly associated with low production (FAO and WFP 2005, FFSSA 2004). The hydrological regime, together with climate seasonality and the geology of the catchment area have been found to influence the spawning success of fishes in many floodplain water bodies (Welcomme 1974). Kolding (1994) and Jul-Larsen *et al.* (2003) found that there is close empirical relationship between fish production indices and water body levels, suggesting that the environment, more than the fishery, is the dominant agent of change in fish production in most water bodies in the southern Africa region.

However, floodplain water body environments are being altered by human developments such as damming, canalisation and irrigation thereby affecting the water level necessary for spawning success of fishes (Welcomme 2003). Competing demands for water use in most floodplain river systems of the sub-Saharan Africa threaten fisheries and the livelihood of many poor, fish-dependent households (Neiland and Béné 2008, WFC 2005). Given that the trend for water demand from the floodplain river systems will continue (Welcomme 2003), innovative ways that clearly demonstrate the value of fisheries to society are not only called for but necessary to attract the attention of policy and decision makers. Heck *et al.* (2007) hinted that fisheries stakeholders must make the case for investment in fisheries much clearer within the context of wider socioeconomic development of the MDGs. Policy and decision makers will also need accurate valuation of the fisheries and better communication of the scientific results in order to raise the profile of fisheries as an option for poverty alleviation in rural areas (Baran *et al*. 2007).

In addition, fisheries and agriculture in general, increasingly face many threats including high rainfall variability. Most of the small-scale fishers and agricultural producers in sub-Saharan Africa operate with limited resources in fragile environments sensitive to even minor shifts in temperature and rainfall pattern (UNDP 2007). For instance, in Malawi, climate change models project temperatures to increase by between 2°C and 3°C by 2050, with a decline in rainfall and reduced water availability for agricultural and fisheries production (GoM 2006b). High rainfall variability is therefore a major threat to food security, water resources, natural resources productivity and biodiversity and threatens to reinforce the already risky situation of most small-holder producers already facing the risks of droughts and floods (Devereux 2002). In areas where fish constitute a significant source of income and protein for poor people, declining fish stocks due to high rainfall variability will worsen the already fragile situation and exacerbate the impacts of diseases such as HIV/AIDS (UNDP 2007). Further, the declining stocks due to the effects of high rainfall variability will negatively impact on the contribution of fisheries to welfare function. A growing realisation is emerging that a holistic understanding of the environmental factors affecting fisheries production is an important step towards sustainable management of the fisheries (Sarch and Allison 2000, Sarch and Birkett 2000, Kapetsky 1998, Plisnier 1997, Lae 1992).

1.8 RATIONALE OF THE STUDY

The potential role of small-scale fisheries as a poverty reduction strategy and as an engine for rural development in developing countries is slowly being recognised (Béné 2006). However, as FAO (2005) observed, most of the small-scale fisheries in developing countries are at the edge of full exploitation or are already over exploited thereby posing serious questions on the future contribution of small-scale fisheries towards welfare function. One of the interests of this study was therefore to assess the current and potential contribution of fishing to reduction in poverty and vulnerability in fishing communities in the two floodplains. The findings of this analysis are expected to inform of the welfare value of floodplain fisheries and therefore influence choice of fisheries management objectives and strategies for sustainable management of the fisheries in the two floodplain areas.

Fisheries management strategies can only be effective with proper understanding of the fishing communities (FAO 2005). Socio-economic information, especially on the part of fishing communities, is hard to find in many sub-Saharan Africa inland small-scale floodplain fisheries (Béné 2009, WFC 2004). The poor understanding of the socio-economic characteristics of fishing households is a cause of dilemma to fisheries managers when weighing between resource conservation and distribution objectives. The need to address this area of concern was the primary motivation for providing information on the socio-economic characteristics of the fishing households in the two floodplain areas. It is expected that the information generated through this study would improve decision making process by fisheries managers in the two floodplains relating to the choice of fisheries management objectives and measures.

Related to understanding welfare function of the fisheries and socio-economic characteristics of the fishing households, it is also important to assess the sustainability of the fisheries with current management regimes and environmental changes. This is necessary in order to determine whether changes in the environment require adaptive fisheries management to ensure future contribution of the fisheries to welfare function in the rural fishing communities. In order to establish this link, the inter-annual relationship between local rainfall and fish production was conducted as a basis to critique current fisheries management strategies. Such an assessment would provide the linkage between environmental change, fisheries management and welfare value of the fisheries. It is expected that this information would provide a holistic view of the fisheries in relation to other sectors for rural development and ensure integration of the floodplain fisheries in rural development plans.

1.9 OBJECTIVES OF THE STUDY

The general objective of the study was to assess the welfare value of inland small-scale floodplain fisheries of the Zambezi River Basin by using the case studies of the Kafue and the Lower Shire floodplains. The specific objectives were:

1. To assess the socio-economic factors affecting the decision to participate in fishing and level of time spent fishing in the two floodplains.
2. To assess the contribution of fishing to poverty and vulnerability reduction in the two floodplains.
3. To compare the role of fishing in the Kafue and the Lower Shire floodplains in relation to contribution to well-being of the floodplain communities.

4. To determine the inter-annual relationship between fish production, farming production and local rainfall.

1.10 HYPOTHESES OF THE STUDY

The major hypothesis of the study was that inland small-scale floodplain fisheries of the Zambezi River Basin significantly reduce poverty and vulnerability in fishing households. The following were the specific hypotheses:

1. The decision to participate in fishing is related to low asset holding and time spent fishing is higher among asset poorer households.
2. Fishing income reduces poverty and vulnerability.
3. Fishing performs more of a safety net role where management levels are weaker and more of a risk spreading role where management levels are stronger.
4. Fish production is low in years of good rainfall because of good agricultural production.

1.11 ORGANISATION OF THE THESIS

The thesis is organised into five chapters. Chapter one is a general introduction which outlines the main concepts from which the rationale, objectives and hypotheses of the study were drawn. Chapters two and three present research approaches and findings in the Kafue and the Lower Shire floodplains, respectively. The two chapters describe the study areas, data collection and analysis methods, results and discussion of the findings. The fourth chapter compares the findings in the Kafue floodplain and the Lower Shire floodplain and highlights the distinct features of the two floodplain communities. The last chapter is a synthesis of the findings in the Kafue and the Lower Shire floodplains with conclusions and recommendations.

1. *A typical shelter in a fishing camp*

2. *Dugout canoes (main fishing craft)*

3. *Men and women mending nets*

4. *Fishermen setting off for fishing*

5. *Women fish traders waiting for fishermen*

6. *Woman fish trader ready for the market*

CHAPTER TWO: THE KAFUE FLOODPLAIN FISHERIES IN ZAMBIA

2.1 INTRODUCTION

Zambia is one of the poorest countries in the world ranked 165 out of 177 countries on the Human Development Index (UNDP 2007). The situation of poverty worsened over the last decade which was characterised by a negative per capita GDP growth due to the collapse of the copper industry as the major export sector (Booysen *et al.* 2008, UNDP Zambia 2007). For instance, the Central Statistical Office in Zambia estimated about 70 per cent of the population living below the national poverty line in the 1990s which had increased to about 73 per cent by the year 2000 (CSO Zambia 2003; World Bank, 2005). Strategies to reverse the economic decline have been articulated in the Fifth National Development Plan of the Republic of Zambia which is in line with the Millennium Development Goals (MDGs) (UNDP Zambia 2007). Agriculture, which includes fisheries, is one of the key sectors prioritized in the national development plan. Since the collapse of the copper industry, agricultural sector is now central to the Zambian economy with more than 75 per cent of the population being active in agriculture, forestry and fisheries (CSO Zambia 2003). However, the agricultural sector faces many constraints including uneven production, effects of rainfall variability, high transportation costs, weak market infrastructure and inadequate access to credits (USAID Zambia 2005).

Given the fact that poverty is higher in rural areas at about 83 per cent compared to about 56 per cent in urban areas (World Bank 2002), rural populations in Zambia face more difficulties than urban populations and their situation is further worsened by disproportionately low levels of access to essential services such as health and education (Malasha 2007, Bond 2006). Some of the rural areas with high prevalence of poverty include those found in fishing communities in the Kafue floodplain in which the research for this chapter was conducted.

The overall objective of this chapter is to assess the welfare value of the Kafue floodplain fishery in alleviating rural poverty and vulnerability in Zambia. Specifically, the chapter:

1. Assesses the socio-economic factors affecting the decision to participate in fishing and level of time spent fishing among households in the Kafue floodplain.

2. Evaluates the relationship between fishing income and expenditure on various items by fishing households in the Kafue floodplain.
3. Investigates the contribution of fishing to poverty and vulnerability reduction in fishing households of the Kafue floodplain.
4. Evaluates the relationship between length of residence in the Kafue floodplain and accumulation of assets.
5. Determines the inter-annual relationship between local rainfall, fisheries production and agricultural production.

2.2 STUDY AREA

2.2.1 Location and extent

The Kafue floodplain is situated between 15°20'-15°55'S and 26°-28°E within the Kafue River (a major tributary of the Zambezi River) and covers an area of about 6,500 km^2 in the Southern Province of Zambia (Chabwela and Mumba 1982; Figure 2.1).

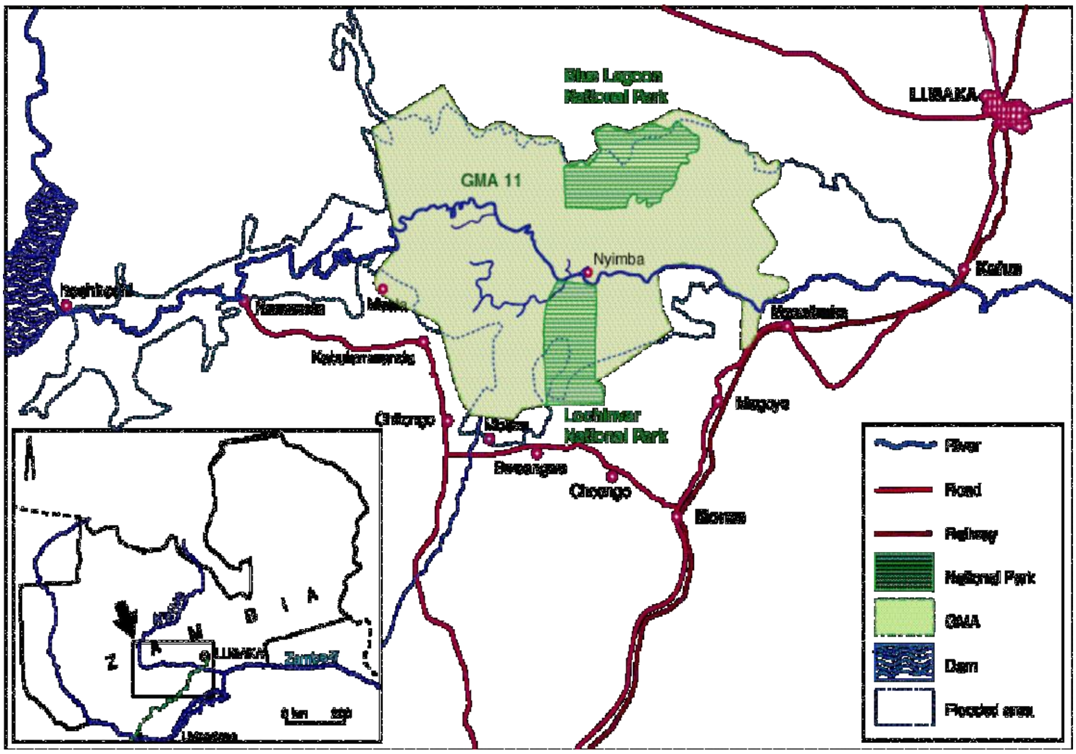

Figure 2.1: Map of the Kafue floodplain

Source: Merten (2004)

The floodplain contains grasslands, lagoons, oxbow lakes and reed beds and supports a diverse range of wildlife and fisheries (WWF Zambia 2004). The area has an annual rainfall of between 600 mm and 780 mm falling between November and April. Temperatures range from 25°C to 35°C. Fish productivity in the Kafue floodplain is greatly influenced by the extent of the floodplain inundated by floodwaters and the annual cycle of flooding and drying (Chapman *et al.* 1971). With the onset of floods during rainy season (November-April), the aquatic grasses and other vegetation begin a period of rapid growth and most of the fish species reproduce around this period (Nyimbili 2006).

The Zambia Centre for Ecology and Hydrology (CEH) reported that the natural flooding regime of Kafue River has been altered with the construction of dams by Zambia Electricity Supply Corporation (ZESCO) for electricity production in the 1970s (CEH Zambia 2001). The first dam was erected in 1971 at Kafue Gorge Dam which is downstream of the Kafue floodplain. Due to low topography, the dam is shallow (about 50m high) and as a result, its water storage capacity did not meet continuous minimal flow required for power generation at Kafue Gorge throughout the year. A second dam was therefore constructed in 1977 at Itezhitezhi, upstream of Kafue floodplain, with water storage capacity necessary to ensure continuous minimum water flow throughout the year (CEH Zambia 2001). The construction of the two dams has affected the natural flooding regime in the Kafue floodplain which was historically dependent on large river flows originating from wetter areas upstream (Mumba and Thompson 2005). With the dams in operation, the time of flooding is at the discretion of the dam operators, ZESCO. Hence commencement of the flooding has been altered to either October or December depending on the amount of water held by ZESCO at Itezhi-tezhi reservoir (Roosmalen 2004). With the dams in place, the mean annual amplitude of water flow has been reduced and so has the average wet season flows whilst the dry season flows have been enhanced due to increased dry season releases from Itezhitezhi reservoir and backward effects caused by the Kafue Gorge Dam (Nyimbili 2006).

Adams (2000) outlined three ways in which upstream damming can affect fish production downstream: dams lead to loss of spawning grounds due to river bed degradation, water from low outlets in dam tends to be cold and is deoxygenated, or rich in sulphides which can kill fish and lastly many floodplain fish are stimulated by rising seasonal flood flows to move into the floodplain to breed. As the flood subsides, fish move back to the river channel. If a dam reduces flood peaks, fish fail to move or breed which reduces the population. This has been observed in Pongolo floodplain in South Africa (Jubb 1972), the Niger below Kainji Dam (Lowe-McConnell 1985) and in Yaeres floodplain in Cameroon (Benech 1992). The changes in the flooding regime do not only have potential impacts on fish reproduction but also on fish production which affect the fishing communities.

2.2.2 Livelihoods in the Kafue floodplain

The Kafue floodplain covers four districts of Itezhi-tezhi, Namwala, Monze and Mazabuka in the Southern Province of Zambia as well as part of the Kafue district in Lusaka Province and a portion of Central Province. The Central Statistical Office in Zambia enumerated a total population of about 1.1 million in areas covered by the floodplain in 2000 (CSO Zambia 2003). About 76 per cent of the population in the Southern Province was estimated to be below the national poverty line in 1998 (CSO Zambia 2003). The area is inhabited mostly by Ila/Balundwe who are transhumant pastoralists who also practice fishing and agriculture (Haller and Merten 2005). The original inhabitants, the Batwa, regarded as hunting and fishing people, are now found in relatively small numbers and have intermarried and integrated with other groups in many areas within the floodplain. Since the 1990s, the Kafue floodplain experienced an influx of Lozi and Bemba fishermen from the Western Province attracted by fishing in the context of high unemployment in Zambia (Petersen 2007). The floodplain is now occupied by a mixture of tribes that pursue a variety of livelihoods mainly livestock rearing, farming and fishing (DoF Zambia *et al.* 2006, Haller and Merten 2005). The floodplain also hosts major irrigated sugar estates and associated industries in Mazabuka district as well as the largest hydro-electric power generating plant in Zambia in Kafue district which offer formal employment to some of the local people (WWF Zambia 2004).

Transport and road infrastructure is very poor over much of the area, resulting in the geographical isolation of the people in many areas within the floodplain, especially in terms of basic service provision including health and education. Many of the fishing camps in the Kafue floodplain are officially classified by government departments as ‘hard-to-reach’ areas (Petersen 2007). For instance, between Monze town and Mbeza is a distance of about 20 km but this takes almost 3 hours to cover on the local pick-ups and a bus that operates only at night for three days in a week (this study). Fish traders have since developed alternative short-cuts to markets with the use of bicycles.

2.2.3 Fisheries of the Kafue floodplain

The Kafue floodplain fishery is typically small-scale, with fishers using mainly dugout canoes. Common fishing gear include gillnets, seinenets and fishtraps. About 67 species of fish have been listed for the whole Kafue River system (WWF Zambia 2004). The bulk of fish catches is made up of *Serranochromis andersonii, S. machrochir, S. anguticeps, Tilapia rendalli* and *Clarias gariepinus* (Nyimbili 2006). Fish production ranged from 3,600 tons to 9,600 tons between 1980 and 2000 (Nyimbili 2006). The fishery is therefore considered important in the local economy in terms of animal protein nutrition and household cash income.

The construction of two large dams around 1970 and 1980 at either end of the Kafue floodplain in order to regulate the water flow for hydro-electricity generation has led to disturbance of the wetland system. The use of these two dams has changed the natural flooding pattern of the wetland so that flooding is irregular, the overall flooded area has reduced and flooding patterns are delayed (with off-season flooding) (Nyimbili 2006). FAO (1968) indicated that reduction or elimination of flood as a result of damming would drastically reduce fish production in the Kafue floodplain. Recently, Nyimbili (2006) reported that fish abundance in the Kafue floodplain was positively correlated with flow level such that regulating flow levels without mimicking the natural flow regime has negative effect on fish abundance.

While fish production would have been expected to vary with rainfall in the past, the impoundments on the system have probably greatly reduced overall fish production, as well as the natural variability in production. This will probably have had a major impact on the livelihoods of local people dependent on the fisheries (Haller and Merten 2005, WWF Zambia 2004, Knaap 1994).

2.2.4 Management of the Kafue floodplain

Legally, the Department of Fisheries has exclusive responsibility in management of the fisheries in Zambia which include the Kafue floodplain fishery except parts of the fishery that fall within the Zambia Wildlife Authority (DoF Zambia 1998, Figure 2.1). The floodplain area that falls within Monze district includes protected areas – a system of National Parks (NPs) and Game Management Areas (GMAs) at Lochinvar, Blue Lagoon and the Kafue Flats National Park. These are covered under the Zambia Wildlife Act 1998 and managed by the

Zambian Wildlife Authority (ZAWA) in conjunction with the WorldWide Fund for Nature. The Zambia Wildlife Act regulates both wildlife and fishing activities within the NPs and GMAs, but at national level in principle coordinates with the Department of Fisheries on fisheries aspects. Within NPs, fishing is officially prohibited under the Act, although not in the GMAs. Nevertheless, according to ZAWA policy at national level, some provision is made to allow resident fishers limited access to the fisheries for subsistence, especially considering that local people were removed from the area now forming the NPs when it was promulgated (Petersen 2007).

DoF Zambia uses the Fisheries Act No. 200 of 1974 as the main instrument of legislation which places issues of fisheries management in the national government with no provisions for community involvement (Malasha 2007). A new fisheries legislation has been drawn up and awaits official ratification by parliament. There are three principle regulations stipulated by the act: gear licensing, mesh size restriction and closed season. To fish, one is required by law to have a permit/licence (but few fishers abide by this law) and use the recommended mesh size and headline of fishing nets. The law stipulates that minimum mesh size should be 7.6 cm in order not to capture juvenile fish. However, DoF Zambia (1998) reported existence of numerous illegal fishing gear and methods such as '*kutumpula*' (bashing water with sticks to drive fish into nets), smaller meshed nets, weirs, seine nets and spears. During part of the rainy season (1st December till 1st March) of each year, the fishery is officially closed to fishing to allow for fish breeding (DoF Zambia 1998). Enforcement of this regulation was reasonably well executed by DoF Zambia prior to the collapse of the copper industry. After the depression in copper earnings, DoF Zambia was inadequately funded which negatively affected implementation of fisheries management activities. Due to inability of DoF Zambia to regulate the sector, co-management arrangements emerged in most of the fisheries (Nyimbili 2006).

While the emergence of co-management in most fisheries in Zambia was influenced by conflicts among actors, health and sanitation matters have informed the type of co-management in the Kafue floodplain fishery due to the isolated nature of the fishing camps and the inadequate social and health services (Malasha 2007). The interaction between fish traders, the majority of whom are female, and the fishers in '*fish-for-sex*' transactions has increased the prevalence of HIV/AIDS (Haller and Merten 2005). There was also a sudden entry of 'economic' immigrants into the Kafue floodplain after the collapse of the copper industry which led to competition over the resource between locals and immigrants and the marginalisation of subsistence fishing causing isolated conflicts (Haller and Merten 2005).

Local fisheries management committees were formed between 2004 and 2005 with common functions of implementing bylaws, monitoring fishing regulations, fighting the HIV/AIDS pandemic, sanctioning those who break the bylaws and regulating fish trade so as to ensure that even local subsistence consumers are also catered for (Kafue Fish Project 2007). There has been a complete end to the paying of ‘entry fees’ to the fishery due to the local reforms. However, the local set-up is currently not recognised by the Zambia’s Fisheries Act of 1974, resulting in declined participation by DoF Zambia officers in the co-management reforms and also due to the fact that DoF Zambia considers health and sanitation that the committees have taken on board as being outside their day to day mandate (Malasha 2007). As a result, the bylaws lack support from DoF Zambia and other sectors of government.

The Kafue floodplain fishery is thus in a state of open access situation and lack enforcement of fishing regulations. In addition, start-up cost/capital is relatively low, with correspondingly easy entry and relatively high returns per effort compared to farming (WWF Zambia 2004). The open access and weaker enforcement of regulations of the fishery provides a pull-factor for unemployed people from all over Zambia as a result of declining macro-economic conditions and high levels of poverty. The proximity of the fisheries to Zambia’s capital city, Lusaka, attracts influxes of people from elsewhere which has led to erosion of traditional institutions and fragmentation of community social cohesion (Petersen 2007). Settlements in the floodplain are therefore characterised by permanent fishing camps and mobile temporary fishing camps which shift according to season and other changes including flooding and variations in catches. The fishing communities (and in particular the poorest and most marginalised) rely to a large extent on aquatic resources and fisheries-related activities to sustain their livelihoods and improve their food and nutritional security. Future provisioning of these livelihood functions by the fisheries would strongly depend on innovative management practices that would ensure increased and sustained fish production.

2.3 METHODS

2.3.1 Survey design

Reconnaissance surveys were conducted using focus group discussions and key informant interviews (Appendix A). These were conducted in order to understand the different stakeholders, livelihood strategies and interaction between fishing and other activities in the floodplain as well as the impact of rainfall variability on fish production. The information was also used in framing of questions for the household surveys. In the household surveys, data was collected using a household questionnaire (Appendix B). The type of data collected in the household survey was in the context of livelihood assets and included but not limited to human capital such as age, education, length of residence in the floodplain and household size; natural capital such as land and fish stock; physical capital such livestock, fishing gear, fishing craft, tools and equipment; financial capital and income from livelihood strategies such as fishing, farming, livestock and off-farm activities; expenditure on food and non-food items; exposure to risks and coping mechanisms adopted.

2.3.2 Sampling strategy

DoF Zambia is under the Ministry of Agriculture and Cooperatives (MoAC). The agricultural stations are the lowest administrative offices for agricultural extension and management which also cover aspects of fisheries extension and management (MoAC 2000). In the Kafue floodplain, there are four administrative strata following Bazigos (1974) that extend across the entire floodplain encompassing the households in the villages that potentially have access to the fishery (Figure 2.1). A household was the sampling unit for the survey. It was defined as a group of individuals continuously living in one house and eating from one pot under the overall leadership of the same household head. Lists of households in each village within the floodplain were obtained from agriculture and fisheries offices which were later verified and updated during key informant interviews and focus group discussions.

In the Kafue floodplain, specialised fishing households are mainly located along the river channel in fishing camps while those that combine fishing with farming are mainly located away from the river channel on the mainland. A stratified random sampling was therefore used to draw households in predominantly fishing and farming villages. In each village stratum, households were randomly sampled every month from June 2007 to July 2008, covering at least one complete flooding cycle. For each month, new households were randomly drawn and interviewed. There are about 170,000 households in the area covered by the Kafue floodplain. About 66 per cent of the households were reported to undertake fishing or fishing related activities in 2003 (CSO Zambia 2003, WWF Zambia 2004).

2.3.3 Data collection

Household data was collected using a survey questionnaire (Appendix B) which was administered by five research assistants who covered all the strata in the entire floodplain. Prior to the survey, the research assistants were trained and also pre-tested the questionnaire during the training. About 70 households were randomly sampled every month for fourteen months with 50 per cent of the households in predominantly farming and fishing villages, respectively, resulting in a total sample size of 980 independent households. The household questionnaire had a mixture of closed and open-ended questions. The questionnaire was in English but the interviews were conducted in local languages. Measurements were reported in local and commonly used units which were later converted to standard units such as hectare[6] (ha) and kilogram (kg). Income and expenditure were reported in local currency of Zambian Kwacha (ZMK) which was later converted to United States Dollars (US$) using the average monthly exchange rate from the Central Bank of Zambia (CBZ). For the period under the survey, the average exchange rate was 1 US$ ≈ ZMK 3,752[7].

Times series data was collected using desk reviews of secondary sources that included academic research and government documents (Appendix C). Local rainfall data was collected from the department of meteorological services. Rainfall data was recorded in millimetres (mm). The data that was collected in inches was converted to millimetres at the rate of 1 inch equivalent to 25.4 mm (WMO 1988). The meteorological department in Zambia is part of the World Meteorological Organisation (WMO) network; thus, the recording procedures are accredited by and comply with the technical regulations specified by the WMO on climate (WMO 1988). Data covered the period between 1957 and 2005.

Fish production data was collected from DoF Zambia and Nyimbili (2006). Fish production was recorded in tons using methods developed by Bazigos (1974) which use monthly catch assessment and annual frame surveys. However, the catch assessment survey has been

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[6] 4 limas ≈ 1 ha (CSO Zambia 2003).

[7] Accessed from Central Bank of Zambia at http://www.boz.zm in March, 2009.

observed as not suitable for floodplain fisheries as the method does not take into account the uneven distribution of fishing gear (Alimoso 1994). Nonetheless, no alternative method has been put in place and fisheries management decisions still depend on the available data collected using the existing methods. Data covered the period from 1957 to 2005.

For the purposes of this study, long-term data on maize production and cattle were collected from the planning department in the Ministry of Agriculture and Cooperatives in Zambia. Maize production was recorded in metric tons. The data collection methods for maize and cattle conform to established international standards on agricultural statistics for crop and livestock estimates (FAO 2005b). The data covered the period from 1975 to 2005.

Population data was collected from Central Statistical Office in Zambia. For years without reported population figures, these were estimated using inter-census population growth rate as reported by the Central Statistical Office. The statistical office in Zambia complies with established international standards on population census (UNDP 1999). Data covered the years between 1975 and 2005.

2.3.4 Data management

Data entry was done in Microsoft Excel 2007 spreadsheet and data cleaning was conducted using pivot tables and scatter plots. Data cleaning involved removing incomplete questionnaires and households with outlier values. Outliers were identified by physically examining the data points on scatter plots and those that were above or below three standard deviations (Payne *et al.* 2008). After removing households with outlier values, a total of 891 households were used in the final analysis which was conducted in Statistical Package for Social Scientists (SPSS) 17.0.

2.3.5 Grouping of households

Jul-Larsen *et al.* (2003) concluded that households in sub-Saharan Africa freshwater fisheries tended to diversify their food and income base to minimise the adverse effects of risks and shocks. This household behaviour was also observed in the Kafue floodplain. Households tended to engage in *fishing* or *farming*[8] in combination with livestock rearing and other off-

[8] For the purposes of this study, fishing implied the act of catching fish in the water bodies of the floodplains for home consumption and sale whereas farming implied production of field crops in areas within the floodplains for home consumption and sale. Processing, trading etc were not taken into account when estimating time spent

farm activities. Following this observation, the analysis in this study grouped households into four groups based on the proportion of household time spent fishing and farming on a 0 to 100 per cent scale in older to provide useful insights on the role of fishing in the communities of the floodplains. The following terminologies were used for the groups:

i. *Specialised fishers*: households that spent 100 per cent of household time in fishing.
ii. *Farming-fishers*: households that spent between 50 and 99 per cent of household time in fishing.
iii. *Fishing-farmer*s: households that spent between 1 and 49 per cent of household time in fishing.
iv. *Specialised farmer*s: households with 0 per cent household time in fishing.

Household labour time was used to group the households against other equally appealing criteria such as wealth ranking or income due to some superior attributes with household time in the area under study: it captures the distinct roles of fishing for subsistence and income, it reflects whether fishing is a safety net or risk spreading strategy and it accounts for presence or absence of alternative livelihood strategies in a particular household. In addition, while other studies categorized households as fishing and non-fishing before sampling [see for instance, Nyimbili (2006), WWF Zambia (2004), Geheb and Binns (1997) and Sarch (1997)], the grouping in this study was done after sampling. This ensured that the probability of a household falling into one of each groups was as random as could be tenable.

In order to further minimise errors in household time from long recall periods and multiplicity of activities, time spent fishing and farming in a month was the basis for the grouping. Also, no household involved in formal employment was encountered in the study area. Time of visiting household members was assumed to be fixed across household groups. Time in fishing and farming by the household members was hypothesised to be imperfect substitutes such that the same household member could not simultaneously fish and farm. This allowed addition of time across members by activity. Such assumptions had also been used in rural Sindhi, Pakistani; in the assessment of determinants of food security and consumption patterns using a non-separable agricultural household model by Shaikh (2007).

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fishing because the idea was to compare fishing and not fishing related activities with other livelihoods such as farming and livestock production. Processing, trading etc were treated as off-farm activities.

Faced with this time constraint, households were assumed to be rational and therefore made time allocation decisions for production and consumption which maximised a social utility function that aggregated preferences across household members (Fafchamps 1993; Chavas *et al*. 2005). In order to maximise the social utility function, the household either engaged in fishing and/or farming to satisfy preferences of household members thereby attaining a state of economic well-being[9]. Households in a state of economic well-being would have higher and reliable sources of income, adequate food for the whole year, high frequency of protein food consumption, access and afford medical care, access and afford education for children, ability to pay for transport costs and ability to withstand crisis situations including famine, disease and inflation. The contrast would be a state of economic ill-being.

2.3.6 Socio-economic characteristics of households

Most of the small-scale fisheries in developing countries are at the edge of full exploitation or are already over exploited (FAO 2005) leading to decline in fish productivity and catch (Pauly *et al.* 2002). There is however a challenge to separate natural variability in fish population from the effects of fishing and environmental change (Hilborn 2007). Fishers may recognise the changes in fish catch due to overexploitation but continue fishing depending on the type of strategies that they develop in response to the declining fish catches (Allison and Ellis 2001). The strategies that are adopted are usually conditioned by the socio-economic characteristics of the fishing households (Cinner *et al*. 2008). The study therefore compared the socio-economic characteristics of households in the four groups using descriptive statistics. Socio-economic factors that determine participation in fishing and the level of fishing were assessed using regression analysis. The regression analysis first used simple linear regression to assess the individual socio-economic factors that determine participation in fishing and the level of fishing. This was done in order to have a better understanding of the relationship between specific socio-economic factors and participation in fishing. Nevertheless, due to the large sample size and almost full information on socio-economic characteristics and the fact that time in fishing was measured on a continuous scale, multiple regression models were also used. The multiple regression models were used in order to identify socio-economic factors that jointly interact to influence the decision to participate in

[9] By 'economic well-being' is implied a status in which the household is able to meet basic needs of its members, contrary to ill-being.

fishing and the level of fishing. The typical multiple regression model was specified following Long (1997) and Payne *et al.* (2008) as:

$$y_i = \beta_0 + \beta_1 x_{i1} + ... + \beta_k x_{ik} + ... + \beta_K x_{iK} + \varepsilon_i \qquad \text{(Equation 2.1)}$$

Where:

y_i = household time (hours) in fishing per month for household *i*,

β_i through β_K are parameters that indicate the effect of a given *x* on *y*.

β_0 is the intercept which indicates the expected value of *y* when all of the x_i are 0.

x_i = vector of independent variables of household *i*, such as age (years) and education (years) of household head; length of residence in the floodplain (years); household size (# of persons); land holding size (ha); number of cattle owned (heads); household income per month (US$); and household labour per month (hours).

ε_i = stochastic error term.

i = the observation number from n random observations.

Two methods of selecting independent variables were used in multiple regression analysis. The first was the enter method in which all variables in a block were entered in a single step and the regression showed estimates that were significant using a probability of F-statistic of ≤ 0.05 for entry of significant variables and the probability of ≥ 0.1 for removal of insignificant variables. The second method was the stepwise method in which the independent variable not in the equation that had the smallest probability of F-statistic was entered, if that probability was sufficiently small also using the probability of F-statistic of ≤ 0.05 for entry and of ≥ 0.1 for removal of independent variables. The two selection methods were jointly used in order to cross-check each model in terms of the predicted socio-economic variables and the power of predictability of the model (Maddala 1988).

The independent variables were assessed if they satisfied the assumptions of classical linear regression model. The adjusted coefficient of determination ($R^2_{adj.}$) was also used to measure the proportion of variation in the dependent variable accounted by regressing the dependent variables on the whole set of explanatory variables. The F-value was used to measure the amount of dependent variable explained by the overall model, also indicating goodness of fit of the model. Standardised coefficients of regressors were reported for the models which take care of constant values and errors. And again, before the variables were used in the analysis, a collinearity diagnostics was done using a simple regression matrix of the variables. The variables with serious indication of multicollinearity were excluded in the models because they violated the assumption of independence, Cov (...) = 0. A Variance Inflation Factor (VIF) was also performed on the independent variables and only variables that had no serious multicollinearity were included in the analysis. A test of serial correlation was also done using Durbin Watson (DW) test. Only variables with a DW value within the tolerable range for lack of autocorrelation were used in the models (Maddala 1988).

2.3.6.1 Operational definition of key independent variables

Household income: Household income was the aggregation of income both in cash and/or in kind that accrued from economic activities performed by the household on a regular basis. Key sources of household income included fishing, farming, livestock and off-farm. Household income was measured as a continuous variable in Malawi Kwacha and Zambia Kwacha and converted to United States of America dollars (US$) using annual/monthly central bank average exchange rates. Fishing income was expected to be positively correlated with time spent fishing while the other sources of income were expected to be negatively correlated with time spent fishing.

Land holding size: This estimated the acreage of the land holding size owned by the household. It was reported in acres and limas in Malawi and Zambia, respectively and then converted into hectares using a conversion rate of 1 ha to 2.4 acres (NSO Malawi 2005) and 1 ha to 4 limas (CSO Zambia 2000). It was recorded as a continuous variable in ha. Households with large land holding size were expected to spend more time in farming than fishing while land constrained households were expected to rely more on fishing than farming as an occupation. Land holding size was therefore hypothesised to have a negative correlation with time spent fishing.

Number of cattle owned: Ownership of cattle was expected to be an indicator of wellbeing with those households with more cattle being considered well-off. It was also expected that households who owned cattle would spent less time in fishing. Number of cattle owned was measured as continuous variable in heads of cattle.

Age of household head: Age is an important factor in any economic activity such as fishing and farming because it is a proxy for experience by the household head and hence affects his/her decision on how limited resources must be allocated among competing economic activities. It was recorded in years as a continuous variable. It was expected that the more years one has, the more experienced they were in the main occupation. A positive relation was therefore expected between age and time spent fishing.

Length of residence in the floodplain by household head: Length of residence in the floodplain was expected to affect ownership of assets such as land and livestock. The level of ownership of land and livestock was therefore expected to influence the decision to participate in fishing. It was measured as a continuous variable in years. It was anticipated that households with more land and livestock especially cattle would opt out of fishing. Length of residence was therefore expected to be negatively correlated with time spent fishing.

Years of education of household head: This looked at the number of years the household head had attended formal education. It was captured as a continuous variable in years. This was an important variable because the more the number of years of formal education, the more likely the household head makes informed decisions and the more he/she recognises the importance of adopting new technologies. A household head with more years of formal education was therefore expected to move away from the traditional occupation into secondary sources of income. A negative correlation was therefore expected with time spent fishing.

Household size: This assessed the total number of people usually living in the same household under the same household head and eating from the same food stock by their gender. It was recorded as a continuous variable. It was expected that households with more male members would have more labour for fishing than households with more female members.

2.3.7 Standardization of income and controlling for inflation

The Development Assistance Committee (DAC) established a set of International Development Goals in 1996 intended to galvanize efforts toward major development challenges and to establish benchmarks for tracking progress toward overcoming those challenges (OECD 1996). The first of those goals was “a reduction by one-half in the proportion of people living in extreme poverty by 2015,” relative to the base year of 1990. Four years later, the United Nations Millennium Declaration of 2000 re-endorsed the poverty goal as the first of the Millennium Development Goals (MDGs) which was set at per capita income of less than US$ 370 per year, or roughly US$ 1 per day.

The US$ 1 per day extreme poverty line represents an extension of the national poverty lines long used by governments to measure the incidence of poverty. The most common approach to setting national poverty lines is the cost of basic needs approach (USAID 2005). However, national poverty lines differ between countries due to differences in typical living conditions prevailing in each country (USAID 2005, Deaton 2001, Fisher 1997, Ravallion 1994). This situation poses an obvious challenge to any effort to track progress toward the MDG for poverty reduction, and for assessing the success of donor strategies focused on reducing global poverty. In order to address this challenge, World Bank analysts working on the 1990 World Development Report developed a methodology for linking poverty lines and poverty measures across countries (Ravallion and Chen 2001). This resulted in the “one-dollar-a-day poverty line at Purchasing Power Parity (PPP) at 1985 prices”. Adjusting for differences in the purchasing power of different currencies allows data from different countries to be placed on a common footing and allows comparison of poverty rates. Later analyses of the PPP based on actual national poverty lines resulted in the US$ 1.08 per day at 1993 consumption purchasing power parity and since then it has been used as the US$ 1 per day poverty line (Chen and Ravallion 2001). The PPP poverty line was revised to US$ 1.25 per day in 2005 (World Bank 2005) and the analysis in this study used this as the reference poverty line.

The international 2005 PPP poverty line was converted into national poverty line for Zambia in local currency. Since the study was conducted during 2007/2008 period, the national PPP poverty line was set at 2007 prices. The following formula based on USAID (2005) was used to calculate the national PPP at 2007 prices:

$$PPP_{2007} = PPP_{2005} * \frac{CPI_{2007}}{CPI_{2005}} \qquad \text{(Equation 2.2)}$$

Where PPP means Purchasing Power Parity and CPI means Consumer Price Index and the subscripts are the reference years. The result was multiplied by US$ 1.25 and the poverty line in Zambia was equivalent to ZMK 4,703 per person per day.

In order to take into account the effects of inflation due to different months of surveying (Appendix D), income was estimated in real terms relative to January 2007 prices based on the following formula:

$$Income_{Jan2007} = Income_{month} * \frac{Inflation_{Jan2007}}{Inflation_{month}} \qquad \text{(Equation 2.3)}$$

2.3.8 Calculation of income poverty

Recent literature on poverty underpins three key dimensions of poverty analysis: breadth (how many poor households), depth (how poor) and duration (for how long) (CPRC 2009, Moore *et al*. 2007). Thus, poverty can manifest in many dimensions, at different levels and can be dynamic resulting in transitory or chronic poverty. There is significant overlap between these three dimensions of poverty; the first and the second dimensions are captured in the indices explained in the proceeding discussion. Economists tend to use income or expenditure as a welfare measure and a poverty line to define who is and is not poor (Barrett 2005). Further, inadequate income is clear, measurable and of immediate concern to individuals (Morduch 2005). This study uses income adjusted to 2007 prices and a poverty line based on 2007 purchasing power parity to assess the welfare value of the Kafue floodplain fisheries to the fishing communities.

The use of income as an indicator of poverty has its weaknesses, mainly the difficult in measurement and variability over a short period of time (Gibson 2005, Morduch 2005). These concerns were genuine in this study. However, proper questionnaire design, focus group discussions and in-depth interview process helped to resolve the problem of income measurement during the surveys. The variability of income over the survey period due to inflation was resolved by controlling the effect of inflation using January 2007 as the base month.

Income poverty was analysed using the FGT (Foster, Greer and Thorbecke 1984) measurements namely; the headcount, the poverty gap, and the squared poverty gap. The

FGT measurements are convenient to use because they can easily be decomposed into a number of components for ease of interpretation (IFPRI 2001). The general formula for the FGT class of poverty measures depends on a parameter α which takes a value of zero for the headcount, one for the poverty gap, and two for the squared poverty gap in the following expression:

$$\mathrm{P}\alpha = \tfrac{1}{n}\sum_{i=1}^{q}\left[\tfrac{z-y_i}{z}\right]^{\alpha}, \qquad \text{(Equation 2.4)}$$

Where *y* is income or expenditure, *z* is the poverty line, *q* is the proportion of poor people in the population and *n* is the population size.

Poverty head count is the proportion of the population for whom consumption or income (*y*) is less than the poverty line (*z*). It is calculated as:

$$H = \frac{q}{n} \qquad \text{(Equation 2.5)}$$

Poverty gap represents the depth of poverty. It is the mean distance separating the population from the poverty line, with the non-poor being at a distance of zero. It is calculated as:

$$PG = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z-y_i}{z}\right] \qquad \text{(Equation 2.6)}$$

Where y_i is the consumption or income of individual *i* and the sum is taken only on those individuals who are poor.

Squared poverty gap measures the severity of poverty. It takes into account the square of the mean distance separating the population from the poverty line thereby giving more weight to the very poor by capturing the inequality among the poor. It is calculated as:

$$P^2 = \frac{1}{n}\sum_{i=1}^{q}\left[\frac{z-y_i}{z}\right]^2 \qquad \text{(Equation 2.7)}$$

In order to estimate the social protection value (SPV) of fisheries in terms of poverty reduction in fishing households, the following formula was used:

$$SPV = \left(P_{nfindex} - P_{findex}\right)PL_{ppp} \quad \text{(Equation 2.8)}$$

Where *SPV* is the social protection value, $P_{nfindex}$ is the poverty index without fishing income, P_{findex} is the poverty index with fishing income and PL_{ppp} is the poverty line at purchasing power parity.

2.3.9 Calculation of economic vulnerability

Vulnerability is the likelihood that at a given time in the future, an individual, a household or a community will fall into or continue to experience poverty (CPRC 2009, Hoddinott and Quisumbing 2003). It results from the presence of hazards and stresses that threaten basic living standards and the actions and buffers deployed by those affected or likely to be affected (CPRC 2009). In the economic arena, these are generally referred to as risks and uncertainties which are stochastic events with known and unknown probability distributions respectively (Siegel and Alwang 1999). Although vulnerability is by no means identical to poverty, it is being recognized as a central element of poverty (Prowse 2003). In the absence of risks or shocks and therefore no vulnerability, poverty can still persist (Hoogeveen *et al.* 2005). Baulch and Hoddinott (2000) observed that the poverty problem is often one involving a large turnover of vulnerable people rather than a large core group of chronically poor.

It is generally agreed that the time dimension of vulnerability essentially requires longitudinal data on income or expenditure for its estimation (Barrett 2005, Chaudhuri *et al.* 2002). Béné (2009) however, observed that in most sub-Saharan Africa or even Asia, such longitudinal data for rural inland small-scale fishing communities is virtually absent. That was the case in the Kafue Floodplain. Lack of longitudinal data recorded for the same households poses a serious constraint to economists to estimate vulnerability in these regions. The first step therefore is to find innovative ways of using cross-sectional data to estimate vulnerability and infer long-term scenarios. Béné (2009) initiated this work by developing an income based vulnerability index that uses cross-sectional data after McCulloch and Calendrino (2003) index:

$$V_i = \Pr ob(y_{it} < z) \quad \text{(Equation 2.9)}$$

Where V_i is the vulnerability index, y_{it} is the total consumption expenditure of household *i* in time *t* and *z* is the poverty line.

To compute the probability function expressed in equation 2.9 for any given year, McCulloch and Calendrino assume the distribution of the inter-temporal consumption for each household to be normal and use the longitudinal component of the individual household data to estimate the mean and variance of this distribution. In order to apply the index to cross-sectional data, Béné (2009) modified it as follows[10]:

$$V_{ig} = CV_g . Dep_{ia} . \frac{1}{Div_i} . Pov_i \qquad \text{(Equation 2.10)}$$

Where V_{ig} is the vulnerability index, CV_g is the coefficient of variation of households' incomes belonging to the same group *g* (as a proxy for exposure to covariate shocks affecting the entire group)[11], Dep_{ia} is the proportion of total cash-income of the household *i* derived from its main activity *a* (Dep_{ia} is a proxy for susceptibility of idiosyncratic shocks affecting individual households). Div_i is activity diversification and $Div_i = A_i(1 - Dep_{ia}) + \sqrt{(Sub_i + 1)}$, with A_i: the total number of activities in which the household *i* is engaged, and the Sub_i: the number of subsistence activities amongst this total number. The first component $A_i(1 - Dep_{ia})$ accounts for the effect of economic diversification, but is weighted by the total relative importance of the complementary activities in which the household is engaged (aside its main income-generating activity *a*). The second component $\sqrt{(Sub_i + 1)}$ accounts for the diversification through subsistence-based activities. The square root is used to capture decreasing marginal positive effect of the subsistence activities on household poverty. A constant 1 is added in the square root to allow for the computation of Div_i in the case where $Dep_{ia} = 1$ and $Sub_i = 0$. A poverty gap, $Pov_i = \sqrt{(z/y_i)}$, is finally added to take into account depth of poverty with *z*: the poverty line, and y_i the per capita cash-income of household *i*. The square root is used as the poverty gap is assumed to have decreasing marginal positive effect on household vulnerability.

Béné (2009) outlined three limitations of the proposed index. Firstly, as is common with many approaches using cross-sectional data, the index assumes that cross-sectional variability

[10] For details of this index, see Béné, C. Assessing Economic Vulnerability in Fishing Communities. *Journal of Development Studies*, Vol. 45, No. 6, 1-23, July 2009.

[11] The variation is assumed to mirror changes in income over time and households' exposure to covariate risks over time is captured through the heterogeneity of the group's income and reflected in CV_g. Hoddinott and Quisumbing (2003:23) points out that this is a strong assumption and requires rigorous analysis to be informative.

in income proxies inter-temporal variation. In essence, the time at which the survey was conducted strongly conditions the results. Secondly, using coefficient of variation as a proxy for covariate exposure to shocks might overshadow income variability due to other factors unrelated to shocks and thirdly the index mainly focuses on income vulnerability while it is recognised that vulnerability is multi-dimensional in nature (Hogan and Marandola 2005, Prowse 2003). The application of the index in this study was based on the assumption that the survey years (2007/2008) were normal years, January 2007 was the normal base year, the floodplain communities were equally exposed to covariate shocks and fishing income was one of the underlying sources of variability in income vulnerability.

Estimate of social protection value of fisheries in terms of vulnerability reduction in fishing households was calculated as follows:

$$SPV = \left(V_{nfindex} - V_{findex}\right) PL_{ppp} \left[1 - \left(\frac{CV_{gnf} - CV_{gf}}{CV_{gf}}\right)\right] \qquad \text{(Equation 2.11)}$$

Where *SPV* is the social protection value, $V_{nfindex}$ is the Vulnerability index without fishing income, V_{findex} is the Vulnerability index with fishing income, PL_{ppp} is the poverty line at purchasing power parity, CV_{gnf} is the group coefficient of variation without fishing income and CV_{gf} is the group coefficient of variation with fishing income.

2.3.10 Time series analysis

In many time series, broad movements can be discerned which evolve more gradually than the other motions which are evident. These gradual changes are described as trends and cycles. The changes which are of a transitory nature are described as fluctuations. In some cases the trend is regarded as an accumulated effect of the fluctuations. In economics, it is traditional to decompose time series into a variety of components, some or all of which may be present in a particular instance. If $\{Y_t\}$ is the sequence of values of a time series variable, then its generic elements are liable to be expressed as (Pollock 2007):

$$Y_t = T_t + C_t + S_t + \varepsilon_t \qquad \text{(Equation 2.12)}$$

Where T_t is the global trend, C_t is the secular cycle, S_t is the seasonal variation and ε_t is an irregular component.

When the foregoing components-the trend, the secular cycle and the seasonal cycle-have been extracted from the variable, the residue should correspond to an irregular component $\{\varepsilon_t\}$ for which no unique explanation can be offered. This component ought to resemble a time series generated by a so-called stationary stochastic process (Box and Jenkins 1976). Such a series has the characteristic that any segment of consecutive elements looks much like any other segment of the same duration, regardless of the date at which it begins or ends. If the residue follows a trend, or if it manifests a more or less regular pattern, then it contains features which ought to have been attributed to the other components defined in equation 2.12.

There are essentially two ways of extracting trends from a time series. The first way is to apply to the series a variety of so-called filters which annihilate or nullify all of the components which are not regarded as trends. One of the filters is a carefully crafted moving average which spans a number of data points to eliminate the secular cycles and seasonal variations. The second way is to fit a function which is capable of adapting itself to whatever form the trend happens to display (Pollock 2007), both of which were used in the analysis.

The q^{th}-order moving average process or MA (q) is defined by:

$$y_t = \mu_0\varepsilon_t + \mu_1\varepsilon_{t-1} + \ldots + \mu_q\varepsilon_{t-q} \qquad \text{(Equation 2.13)}$$

Where μ_t is the error term and ε_t, which has $E\{\varepsilon_t\} = 0$, is a white-noise process consisting of a sequence of independently and identically distributed (*i.i.d*) random variables with zero expectations (Pollock 2007). The equation is normalised by either setting $\mu_0 = 1$ or by setting $V\{\varepsilon_t\} = \sigma^2\varepsilon = 1$. The equation can be written in summary notation as:

$$y_t = \mu(L)\varepsilon_t$$ (Equation 2.14), where:

$$\mu(L) = \mu_0 + \mu_1 L + \ldots + \mu_q L^q$$ is a polynomial lag operator.

A moving average process is stationary since any two elements y_t and y_s represents the same function of the vectors [$\varepsilon_t, \varepsilon_{t-1}, \ldots, \varepsilon_{t-q}$] and [$\varepsilon_s, \varepsilon_{s-1}, \ldots, \varepsilon_{s-q}$] which are identically distributed. In addition to stationarity, it is usually required that a moving average process should be invertible such that it can be expressed in the form:

$$\mu^{-1}(L)y_t = \varepsilon_t \qquad \text{(Equation 2.15)}$$

Where the left hand side embodies a convergent sum of past values of y_t. This is an infinite-order autoregressive representation of the process which is available only if all the roots of the equation:

$$\mu(z) = \mu_0 + \mu_1 z + ... + \mu_q z^q = 0$$

lie outside the unit circle. This condition is called invertibility condition, which assumes that the variance of ε_t tends to a limiting value (constant σ^2) rather than increasing without limit as time, *t*, gets large. In order to fit a regression function to the moving average process, differencing of first order was conducted for both stationarity and invertibility conditions to be achieved. The data showed no serious partial autocorrelations (Appendix E).

2.4 RESULTS

2.4.1 Socio-economic characteristics of households in the Kafue floodplain

About 26 per cent of the sample households were specialised fishers, 44 per cent were farming-fishers, 9 per cent were fishing-farmers and 21 per cent were specialised farmers (Table 2.1). Specialised fishers had fewer household members and had a shorter period of stay in the floodplain than specialised farmers ($p < 0.01$; Table 2.1). Male members of specialised fishers and farming-fishers contributed more time to household labour per month than female members while male members of fishing-farmers and specialised farmers contributed less time to household labour than their female counterparts ($p < 0.001$; Table 2.1).

The size of land holding was smaller among specialised fishers than the rest of the other groups and specialised fishers also owned fewer cattle when compared with fishing-farmers and specialised farmers ($p < 0.001$; Table 2.1). Household income was lower among specialised fishers than the other groups but income from fishing was higher among specialised fishers than fishing-farmers ($p < 0.001$; Table 2.1). Specialised fishers had lower income from livestock as compared to the other groups and lower income from off-farm activities when compared to specialised farmers ($p < 0.001$; Table 2.1).

Table 2.1: Comparison of socio-economic characteristics of household groups in the Kafue floodplain, 2007/2008

		Specialised fishers^{a}	**Farming-fishers^{b}**	**Fishing-farmers^{c}**	**Specialised farmers^{d}**	**F-test (across groups)**
	n	233	394	81	183	
Household demographics:						
HH size (# of persons):	Mean	$4.5^{c*,d**,b***}$	5.6	5.5	5.5	$F = 9.921$,
	SE	0.16	0.13	0.28	0.18	$df = 3, 887$; $p < 0.001$
Age of HH head (years):	Mean	42.0	41.7	40.5	43.1	$F = 0.929$,
	SE	0.82	0.62	1.37	0.93	$df = 3, 887$; n.s.
Education of HH head (years):						
	Mean	2.3	2.5	1.4	2.1	$F = 2.143$,
	SE	0.22	0.18	0.31	0.24	$df = 3, 887$; n.s.
Length of residence (years):						
	Mean	15.6^{d***}	18.7	20.0	21.4	$F = 5.764$,
	SE	0.86	0.75	1.67	1.14	$df = 3, 887$; $p < 0.01$
Male labour per month (hours):						
	Mean	$275.8^{b,c,d***}$	$345.2^{c,d***}$	155.2^{d*}	92.8	$F = 125.626$,
	SE	9.8	8.9	18.6	6.3	$df = 3, 887$; $p < 0.001$
Female labour per month (hours):						
	Mean	$104.3^{b,c***}$	$175.9^{c**,d***}$	225.9^{d***}	116.3	$F = 37.173$,
	SE	7.5	6.4	12.0	5.3	$df = 3, 887$; $p < 0.001$
Household assets:						
Land holding size (ha):	Mean	$0.18^{b,c,d***}$	$0.67^{c,d***}$	1.13^{d*}	1.38	$F = 127.27$,
	SE	0.03	0.03	0.09	0.06	$df = 3, 887$; $p < 0.001$
Number of cattle (heads):						
	Mean	$1.3^{c,d***}$	2.4^{d**}	4.1	4.0	$F = 10.693$,
	SE	0.27	0.26	0.83	0.49	$df = 3, 887$; $p < 0.001$
Household income:						
Total income per month (US$):						
	Mean	$83.82^{b,c**,d***}$	157.98	187.92	212.4	$F = 9.853$,
	SE	9.04	13.25	27.46	24.24	$df = 3, 887$; $p < 0.001$
Fishing income per month (US$):						
	Mean	$48.3^{c*,d***}$	$46.68^{c*,d***}$	27.88^{d***}	0.00	$F = 39.359$,
	SE	3.8	3.07	5.25		$df = 3, 887$; $p < 0.001$
Farming income per month (US$):						
	Mean	$4.39^{c**,d***}$	13.35^{d***}	25.83^{d*}	42.17	$F = 29.981$,
	SE	1.55	1.8	5.79	4.77	$df = 3, 887$; $p < 0.001$
Livestock income per month ($):						
	Mean	$23.89^{b,c**,d***}$	88.68^{d**}	121.46	151.98	$F = 12.212$,
	SE	7.78	11.83	22.05	21.52	$df = 3, 887$; $p < 0.001$
Off-farm income per month (US$):						
	Mean	7.25^{d***}	9.34^{d***}	12.75	18.24	$F = 8.402$,
	SE	1.5	0.97	2.92	2.27	$df = 3, 887$; $p < 0.001$

df = degrees of freedom, n.s. = not significant, *F*-test based on one way ANOVA, SE = Standard Error.
*The superscripts show one way ANOVA Post-Hoc tests for pairwise comparison of means based on Sidak statistic. Only significant pairwise mean comparisons are shown by letters a, b, c and d which represents the household groups, respectively. * = significant at $p < 0.05$, ** significant at $p < 0.01$ and *** = significant at $p < 0.001$.*

2.4.2 Socio-economic factors related to participation in fishing and level of time in fishing

The results indicated that the decision to participate in fishing in the Kafue floodplain was negatively correlated with land holding size, number of cattle owned, length of residence in the floodplain, income from farming, income from livestock and income from off-farm activities but was positively correlated with household labour (Table 2.2).

Table 2.2: Linear relationships between level of time in fishing and related socio-economic factors in Kafue floodplain, 2007/2008.

Dependent variable: Time spent fishing per month (hours) against:	**Standardised b**	**R^2**	**p**
Total land holding size (ha)	-0.422	0.18	<0.001
Number of cattle owned (heads)	-0.174	0.03	<0.001
Length of residence in the floodplain (years)	-0.11	0.012	<0.01
Farming income per month (US$)	-0.273	0.074	<0.001
Livestock income per month (US$)	-0.17	0.025	<0.001
Off-farm income per month (US$)	-0.16	0.025	<0.001
Labour of female members per month (hours)	0.303	0.09	<0.001

n = 891

Table 2.3: Results of multiple regression analysis on the socio-economic factors related to participation in fishing in the Kafue floodplain, 2007/2008

	OLS Enter method		**OLS Stepwise method**	
Dependent: Time spent fishing per month (hours)	**Standardised Coefficient**	**t-statistic**	**Standardised Coefficient**	**t-statistic**
Land holding size (ha)	-0.258	-13.531***	-0.256	-15.605***
Number of cattle owned (heads)	-0.005	-0.222		
Length of residence (years)	-0.029	-1.726	-0.032	-1.986*
Household size (# of persons)	0.001	0.068		
Age of household head (years)	0.001	0.05		
Education of household head (years)	0.021	1.315		
Farming income per month (US$)	0.006	0.307		
Livestock income per month (US$)	-0.041	-1.911	-0.045	-2.772**
Off-farm income per month (US$)	-0.008	-0.483		
Labour by male members per month (hours)	0.725	45.611***	0.726	46.051***
Labour by female members per month (hours)	0.333	21.341***	0.333	21.688***
F statistic	***306.829**** ***		***677.581**** ***	
df	***11, 879***		***5, 885***	
R^2	***0.793***		***0.793***	
Adjusted R^2	***0.791***		***0.792***	

n = 891, OLS = Ordinary Least Squares, = significant at p < 0.05, ** = significant at p < 0.01, *** = significant at p < 0.001.*

Multiple regression analysis was used in order to account for interaction between factors and to determine factors that jointly affected the decision to participate in fishing among fishing households in the Kafue floodplain. The results in Table 2.3 show that the decision to participate in fishing had significant negative relationship with land holding size, income from livestock and length of residence in the floodplain and was positively correlated with labour from both male and female members. The multiple regression analysis generated a higher goodness of fit ($R^2 = 0.79$, Table 2.3) than any of the simple linear regression models which showed that about 79 per cent of the variation in the decision to participate in fishing was explained by the variables used in the model ($p < 0.001$, Table 2.3).

Table 2.4: Socio-economic factors affecting the level of time spent fishing in the Kafue floodplain, 2007/2008

	OLS Enter method		**OLS Stepwise method**	
Dependent: Time spent fishing per month (hours)	**Standardised Coefficient**	**t-statistic**	**Standardised Coefficient**	**t-statistic**
Land holding size (ha)	-0.236	-10.594***	-0.224	-11.507***
Number of cattle owned (heads)	-0.029	-1.224	-0.041	-2.161*
Length of residence (years)	-0.026	-1.228		
Household size (# of persons)	0.015	0.757		
Age of household head (years)	0.029	1.453		
Education of household head (years)	0.025	1.295		
Farming income per month (US$)	0.027	1.244		
Livestock income per month (US$)	-0.015	-0.621		
Off-farm income per month (US$)	0.025	1.259		
Labour by male members per month (hours)	0.761	39.733***	0.761	40.147***
Labour by female members per month (hours)	0.407	20.979***	0.399	20.88***
F statistic	***195.275****		***533.083****	
df	***11, 696***		***4,703***	
R^2	***0.755***		***0.752***	
Adjusted R^2	***0.751***		***0.751***	

n = 708, OLS = Ordinary Least Squares, = significant at p < 0.05, ** = significant at p < 0.01, *** = significant at p < 0.001.*

The results in Table 2.4 show that the level of time spent fishing had significant negative relationship with land holding size and number of cattle owned while it was positively correlated with labour from both male and female members. The goodness of fit was also high and significant ($R^2 = 0.75$, $p < 0.001$, Table 2.4) and the normality assumptions were not seriously violated (Appendix F1).

2.4.3 Contribution of fishing to income and animal protein

The mean proportion of total household income provided by fishing decreased from specialised fishers to specialised farmers while that provided by livestock and farming increased from specialised fishers to specialised farmers (Figure 2.2). There was no clear pattern for the mean proportion of income from off-farm activities across household groups but specialised farmers had higher proportion of total household income from off-farm activities (Figure 2.2). The mean proportions of income to total household income from the main sources of income were statistically different across household groups ($F_{fishing\ (3,\ 887)}$ = 213.982, $p < 0.001$; $F_{farming\ (3,887)}$ = 35.953, $p < 0.001$; $F_{livestock\ (3,\ 887)}$ = 41.256, $p < 0.001$; $F_{off\text{-}farm\ (3,\ 887)}$ = 5.293, $p < 0.01$; Figure 2.2).

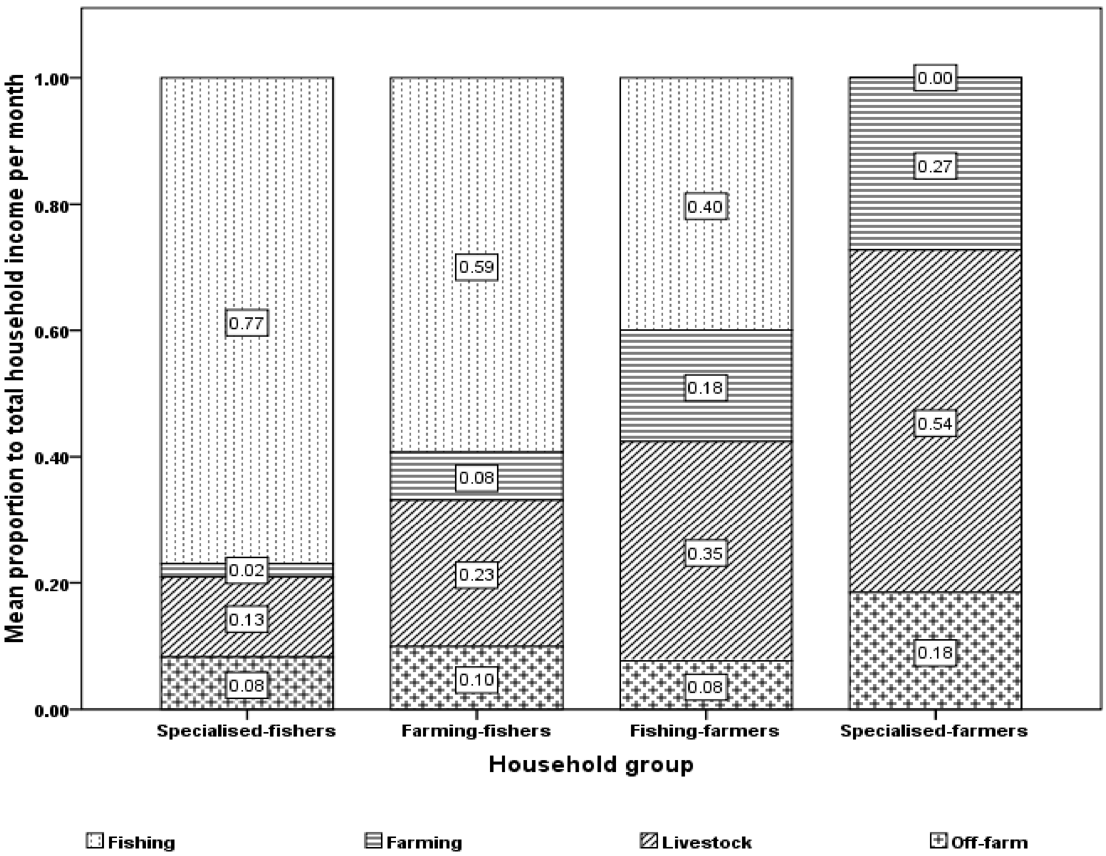

Figure 2.2: Mean proportional contribution of main sources of income to total household income per month across household groups in the Kafue floodplain, 2007/2008.

The average proportional contribution of fish to animal protein (defined as meat, fish and milk) consumption per month in the Kafue floodplain decreased from specialised fishers to specialised farmers while that of meat and milk increased from specialised fishers to specialised farmers (Figure 2.3). The mean proportional contribution per month of fish to animal protein consumption was statistically different across household groups ($F_{fish\ (3,\ 864)}$ = 8.069, $p < 0.001$; $F_{meat\ (3,\ 864)} = 2.135$, $p > 0.05$; $F_{milk\ (3,\ 864)} = 0.459$, $p > 0.05$; Figure 2.3).

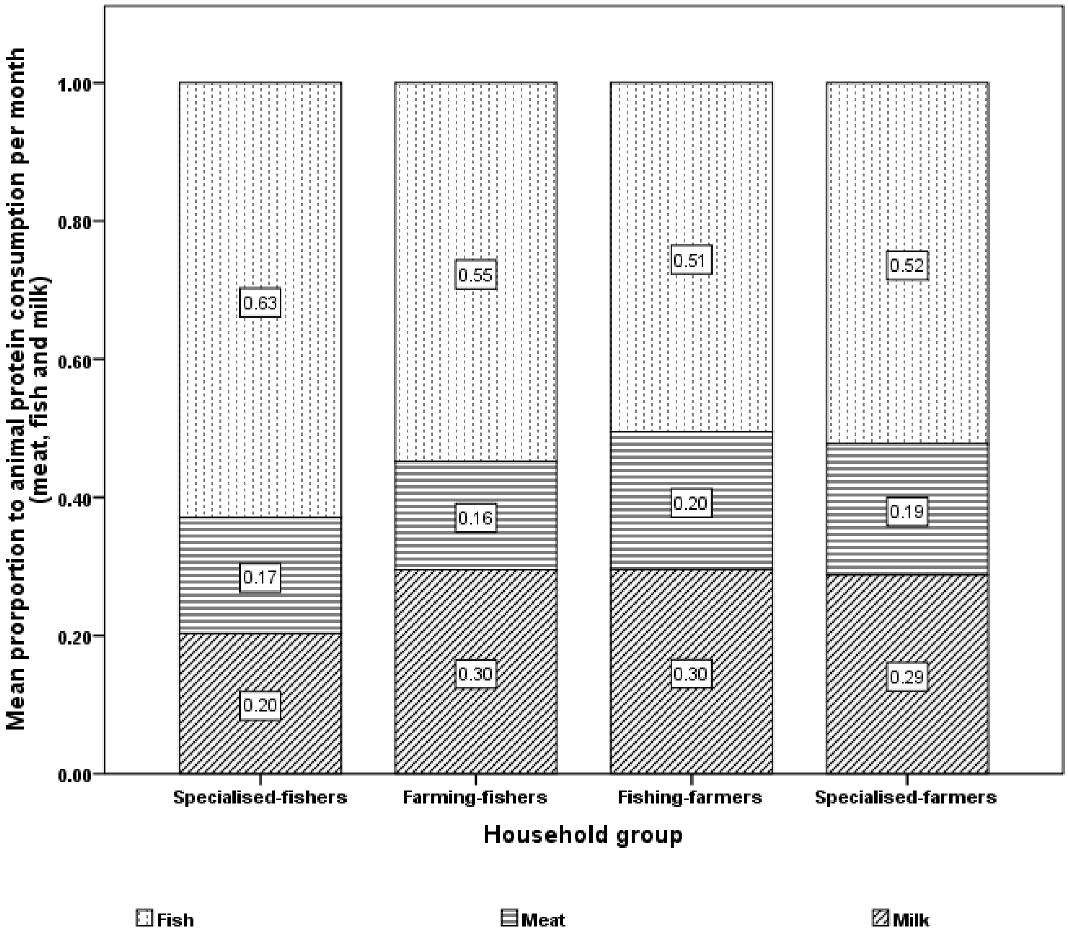

Figure 2.3: Mean proportional contribution of meat, fish and milk to household animal protein consumption per month across household groups in the Kafue floodplain, 2007/2008.

2.4.4 Relationship between income from fishing and expenditure of fishing households

Correlations between level of income from fishing and expenditure were also conducted to assess the relationship between fishing income and level of expenditure on various items by fishing households. The results in Table 2.5 show that there was significant positive correlation between income from fishing and expenditure on food, expenditure on transport, expenditure on education, expenditure on loan servicing, expenditure on farm inputs, expenditure on household amenities (clothes, charcoal, firewood, kerosene, soap, body lotions) and expenditure on household assets (furniture, bicycle, housing, livestock).

Table 2.5: Linear relationships between income from fishing per month and expenditure of fishing households in Kafue floodplain, 2007/2008.

Fishing income per month versus expenditure on:	**Standardised b**	**R^2**	**p**
Food (US$)	0.241	0.058	<0.001
Transport (US$)	0.119	0.014	<0.01
Education (US$)	0.115	0.013	<0.01
Loan servicing (US$)	0.194	0.038	<0.001
Farm inputs (US$)	0.089	0.008	<0.05
Household amenities (US$)	0.291	0.085	<0.001
Household assets (US$)	0.218	0.047	<0.001

n = 708

2.4.5 The effect of income from fishing on poverty and vulnerability

Fishing income was significant in reducing the incidence of income poverty head count among fishing households in the Kafue floodplain (t = 50.339, p < 0.001, n = 694; Figure 2.4). However, the incidence of income poverty with and without fishing income was higher among specialised fishers and farming-fishers than among fishing-farmers and specialised farmers ($F_{without}$ = 8.131E6, p < 0.001, n = 694; F_{with} = 4.333E29, p < 0.001, n = 745, respectively; Figure 2.4).

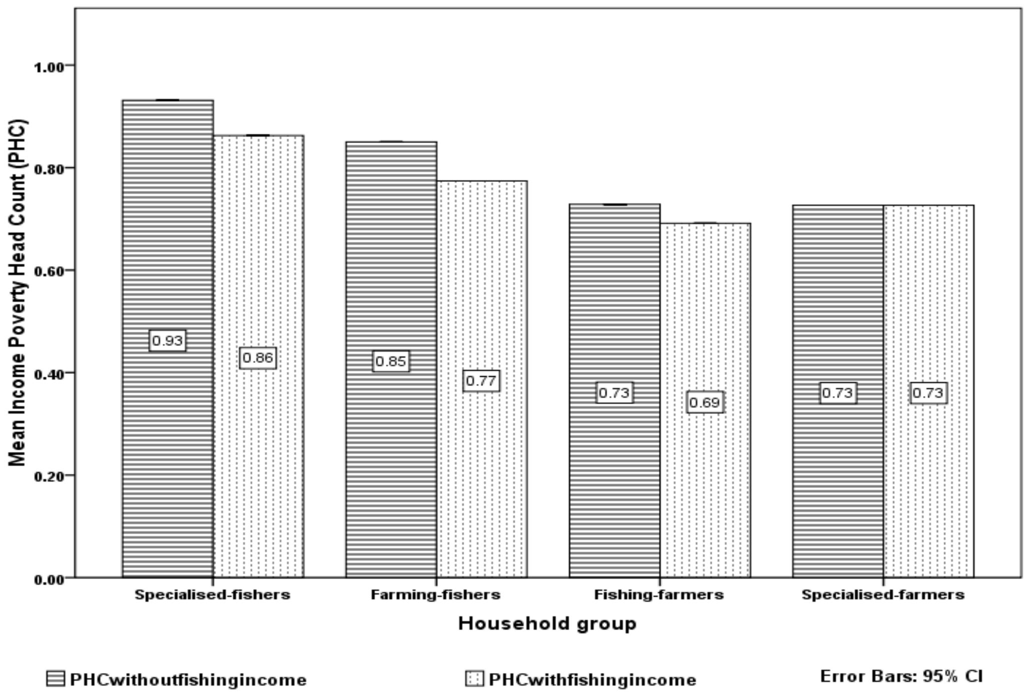

Figure 2.4: Income Poverty Head Count Index with and without fishing income in household groups of the Kafue floodplain, 2007/2008.

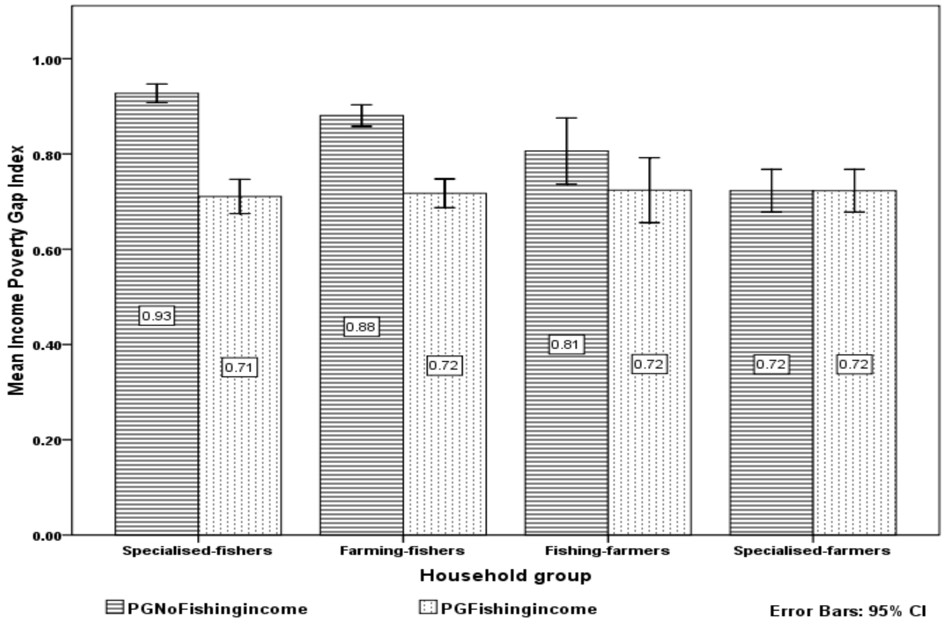

Figure 2.5: Income Poverty Gap Index with and without fishing income in household groups of the Kafue floodplain, 2007/2008.

Fishing income was significant in reducing the depth of income poverty among fishing households in the Kafue floodplain (t = 19.668, p < 0.001, n = 695; Figure 2.5). The depth of income poverty without fishing income was higher among fishing households than specialised farmers but was statistically not significantly different between fishing households and specialised farmers with fishing income ($F_{without}$ = 21.197, p < 0.001, n = 744; F_{with} = 0.074, p > 0.05, n = 695, respectively; Figure 2.5).

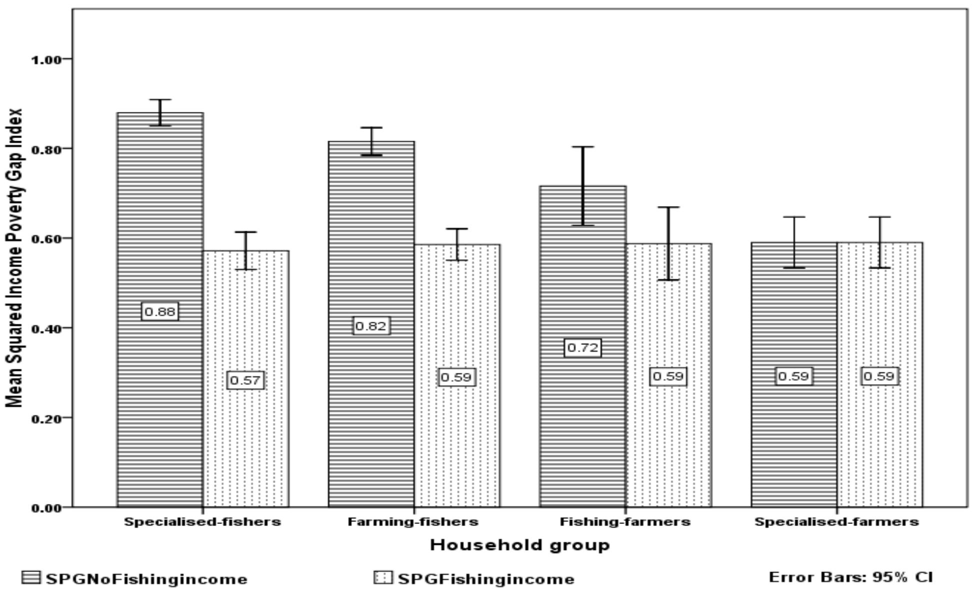

Figure 2.6: Income Squared Poverty Gap Index with and without fishing income in household groups of the Kafue floodplain, 2007/2008.

Fishing income was significant in reducing the severity of income poverty among fishing households in the Kafue floodplain ($t = 22.121$, $p < 0.001$, n = 695; Figure 2.6). The severity of income poverty without fishing income was higher among fishing households than specialised farmers but was statistically not significantly different between fishing households and specialised farmers with fishing income ($F_{without} = 25.296$, $p < 0.001$, n = 744; $F_{with} = 0.124$, $p > 0.05$, n = 695, respectively; Figure 2.6).

Fishing income was significant in reducing economic vulnerability among fishing households in the Kafue floodplain ($t = 12.184$, $p < 0.001$, n = 604; Figure 2.7). Economic vulnerability without fishing income was significantly higher among fishing households than specialised farmers but was significantly higher among specialised farmers than fishing households with fishing income ($F_{without} = 10.653$, $p < 0.001$, n = 604; $F_{with} = 2.933$, $p < 0.05$, n = 604, respectively; Figure 2.7).

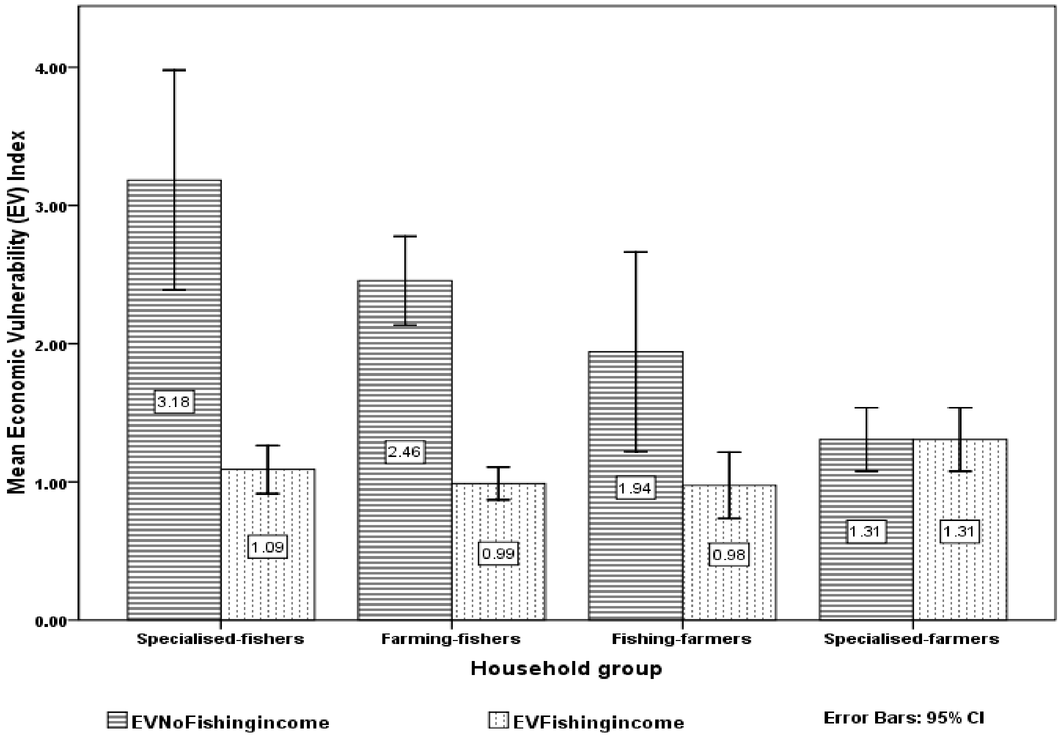

Figure 2.7: Economic Vulnerability Index with and without fishing income in household groups of the Kafue floodplain, 2007/2008.

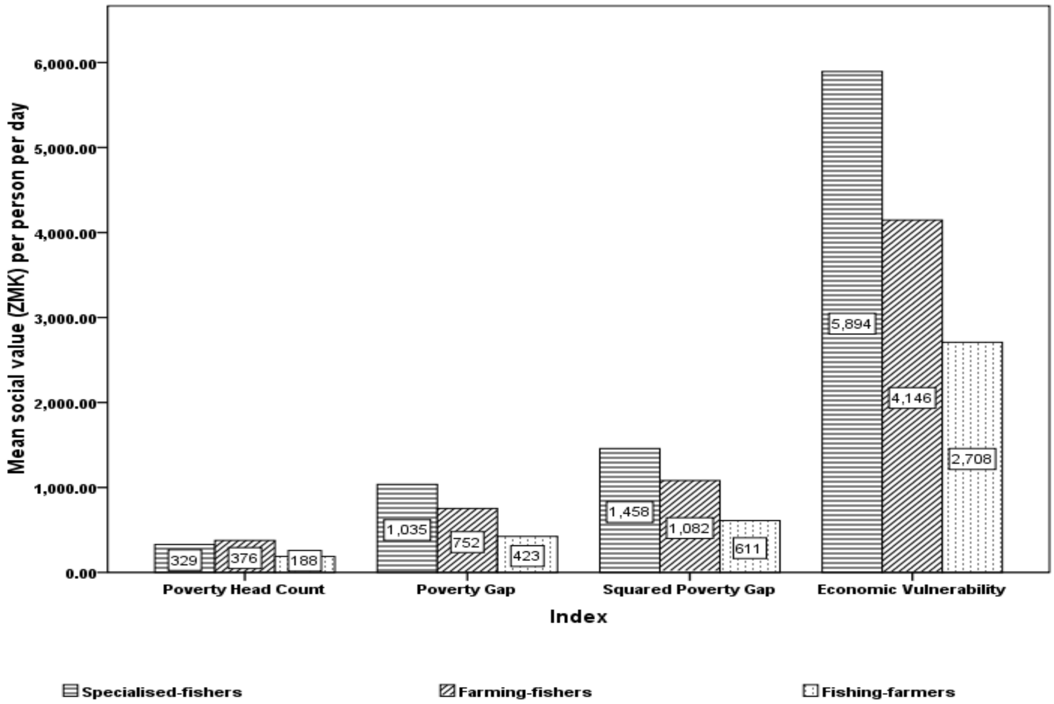

Figure 2.8: Estimates of social protection value of fishing in fishing households of the Kafue floodplain, 2007/2008. (1 US$ = ZMK 3,752).

The effect of fishing income as a social protection mechanism per person per day in fishing households of the Kafue floodplain increased with increasing depth and severity of poverty and incidence of economic vulnerability (Figure 2.8).

2.4.6 Length of residence in the Kafue floodplain and accumulation of assets

Length of residence by fishing households in the Kafue floodplain was positively correlated with accumulation of land and cattle (Table 2.6).

Table 2.6: Linear relationships between length of residence in the floodplain and accumulation of land and cattle by fishing households in Kafue floodplain, 2007/2008.

Dependent: Length of residence in the floodplain (years) against:	**Standardised b**	**R^2**	**p**
Land holding size (ha)	0.099	0.01	<0.01
Number of cattle owned (heads)	0.24	0.058	<0.001

n = 707

2.4.7 The inter-annual trends in local rainfall, fisheries and agricultural production

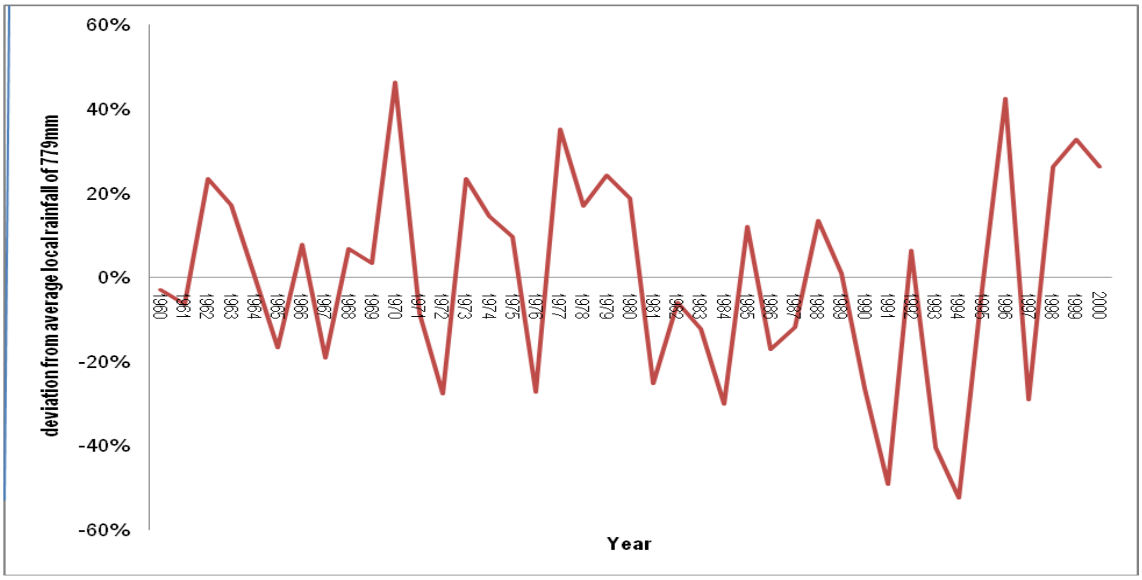

Figure 2.9: The inter-annual trend in local rainfall variability in the Kafue floodplain, 1960-2000

Figure 2.9 shows that there was low local rainfall variability between 1960 and 1970 with six seasons of above average local rainfall; high local rainfall variability between 1970 and 1980 with seven seasons of above average local rainfall; low local rainfall variability between 1980 and 1990 with seven seasons of below average local rainfall; and high local rainfall variability between 1990 and 2000 with five seasons of below average local rainfall. The inter-annual variations in annual local rainfall were higher between 1990 and 2000 and there was frequent occurrence of below average local rainfall since 1981 (Figure 2.9).

Figure 2.9 also shows that deviations of at least 40 per cent below the long-run average in local rainfall occurred in 1991 (-49 per cent), 1993 (-40 per cent) and 1994 (-52 per cent) suggesting that the period between 1990 and 1995 was associated with high below average local rainfall. There was no significant long-term trend in annual local rainfall from 1960 to 2000 ($t = 0.001$, $p > 0.05$, n = 40) (Figure 2.9).

There was significant long-term trend in annual fish production from 1960 to 2000 ($t = 3.03$, $p < 0.01$, n = 40; Figure 2.10). The period between 1960 and 1970 which was associated with low local rainfall variability and above average local rainfall had rising but higher variations in annual fish production and fish production had significant positive correlation with annual local rainfall (r = 0.64, $p < 0.05$, n = 10; Figure 2.10). The period between 1970 and 1980 which was associated with high local rainfall variability and above average local rainfall had rising and lower variations in annual fish production and fish production had insignificant positive correlation with annual local rainfall (r = 0.01, p > 0.05, n = 10; Figure 2.10). The period between 1980 and 2000 which was associated with below average local rainfall had declining and moderate variations in annual fish production and fish production had no correlation with local rainfall (r = -0.10, p > 0.05, n = 21; Figure 2.10).

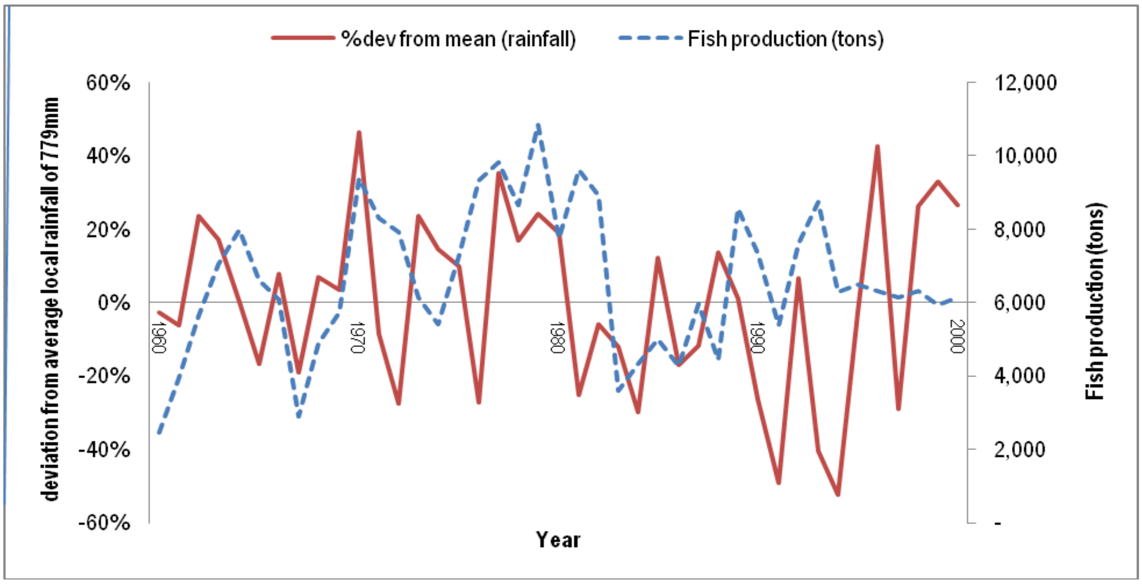

Figure 2.10: Inter-annual relationship between local rainfall variability and fish production in Kafue floodplain, 1960-2000

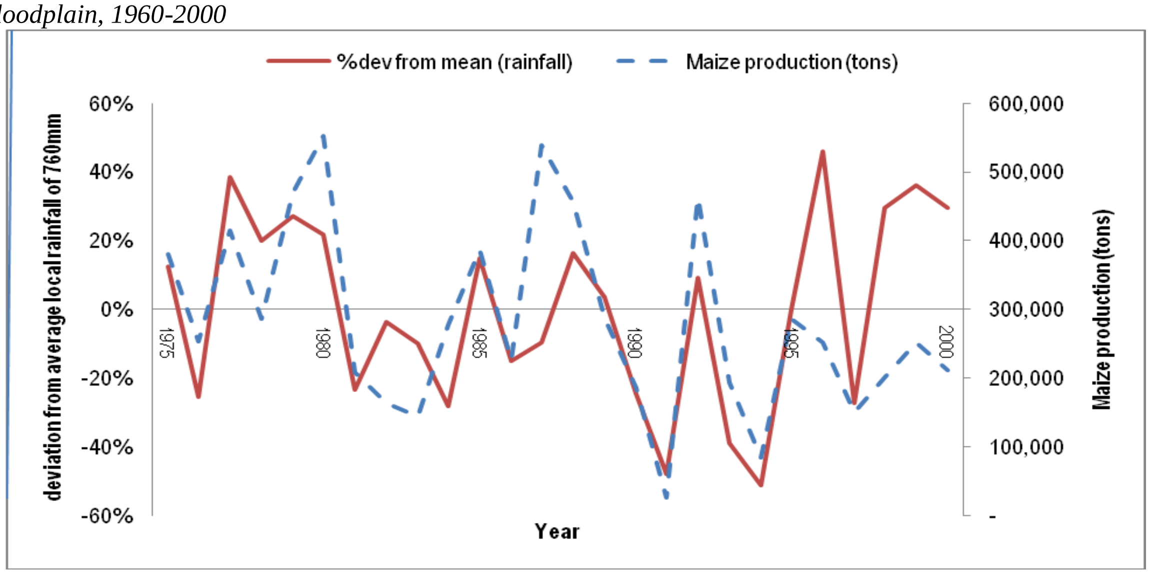

Figure 2.11: Inter-annual relationship between local rainfall variability and maize production in Kafue floodplain, 1975-2000

There was insignificant long-term trend in the annual maize production from 1975 and 2000 (t = 0.015, p > 0.05, n = 25; Figure 2.11). Annual maize production had significant positive correlation with annual local rainfall variability between 1975 and 2000 ($p < 0.05$; Figure 2.11).

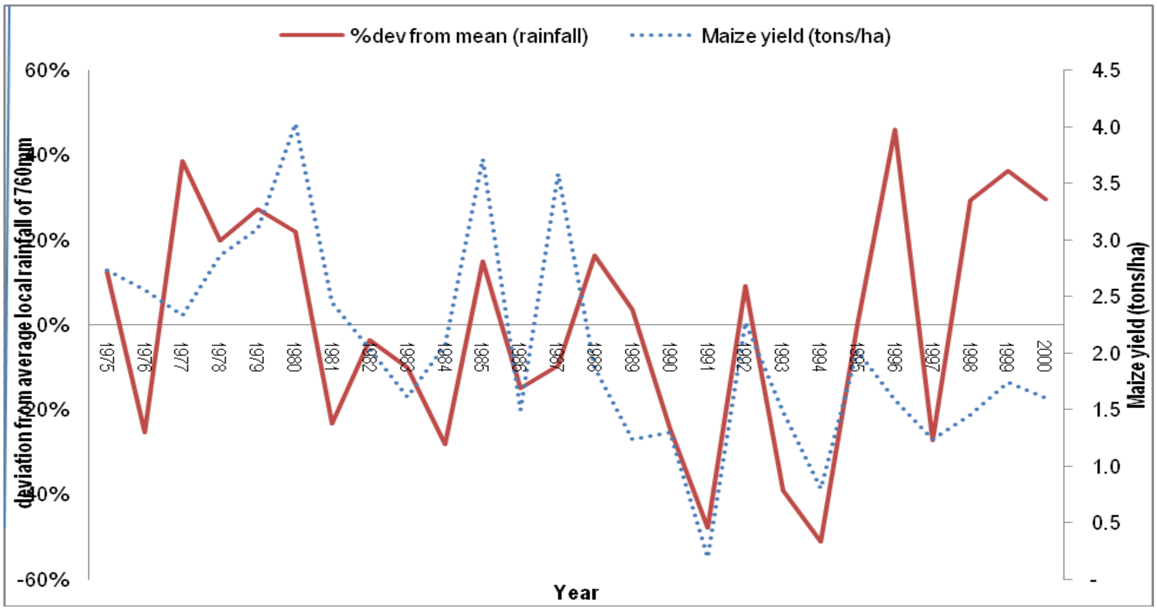

Figure 2.12: Inter-annual relationship between local rainfall variability and maize yield in Kafue floodplain, 1975-2000

There was insignificant long-term trend in the annual maize yield from 1975 and 2000 (t = 0.015, $p > 0.05$, n = 25) but annual maize yield had significant positive correlation with annual local rainfall variability ($p < 0.05$; Figure 2.12). Since 1981, annual maize yield had largely been less than 2.0 tons per ha suggesting that maize productivity had generally declined in the floodplain. This was also the period associated with high variability and below average local rainfall.

Fish production had positive correlation with changes in maize production (r = 0.20, $p < 0.05$, n = 26; Figure 2.13) with years of above average maize production associated with rising fish production and years of below average maize production associated with declining fish production (Figure 2.13) confirming earlier findings that both maize production and fish production in Kafue floodplain had positive correlation with local rainfall patterns.

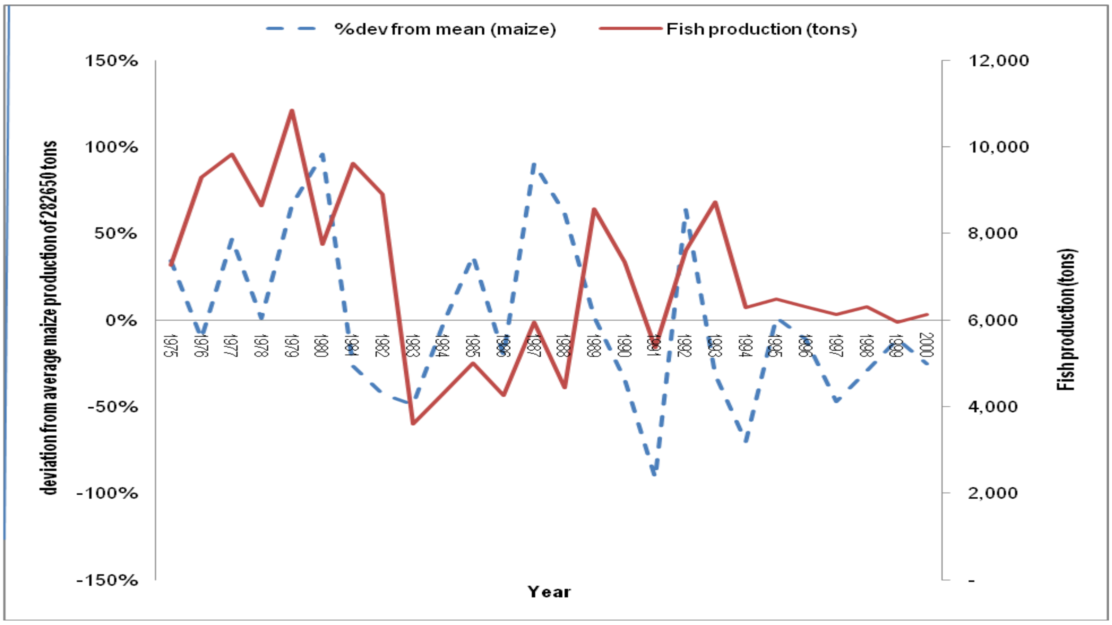

Figure 2.13: Inter-annual relationship between changes in maize production and fish production in Kafue floodplain, 1975-2000

There was significant long-term trend in the population of cattle in the Kafue floodplain between 1980 and 2000 (t = 2.588, $p < 0.05$, n = 20; Figure 2.14). The trend in cattle population showed no relationship with the variability in local rainfall suggesting that livestock production was somewhat resilient to fluctuations in local rainfall patterns.

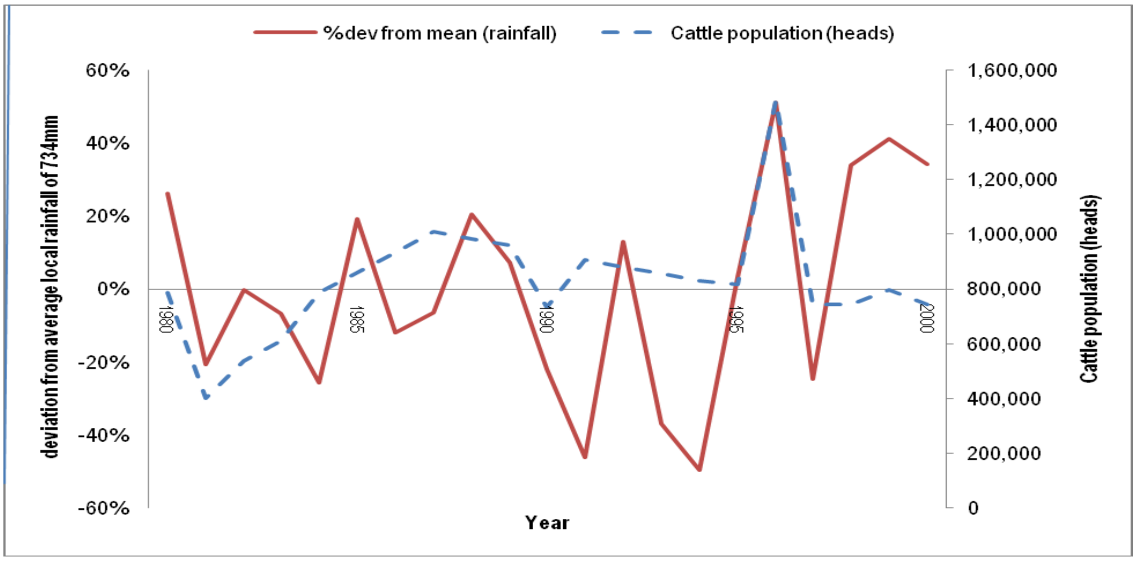

Figure 2.14: Inter-annual relationship between local rainfall variability and cattle population in Kafue floodplain, 1980-2000

Fish production had negative correlation with changes in cattle population (r = -0.269, $p <$ 0.05, n = 21; Figure 2.15) with years of rising numbers in cattle associated with declining fish production suggesting that there is an exit path from fisheries with rising numbers of cattle in Kafue floodplain.

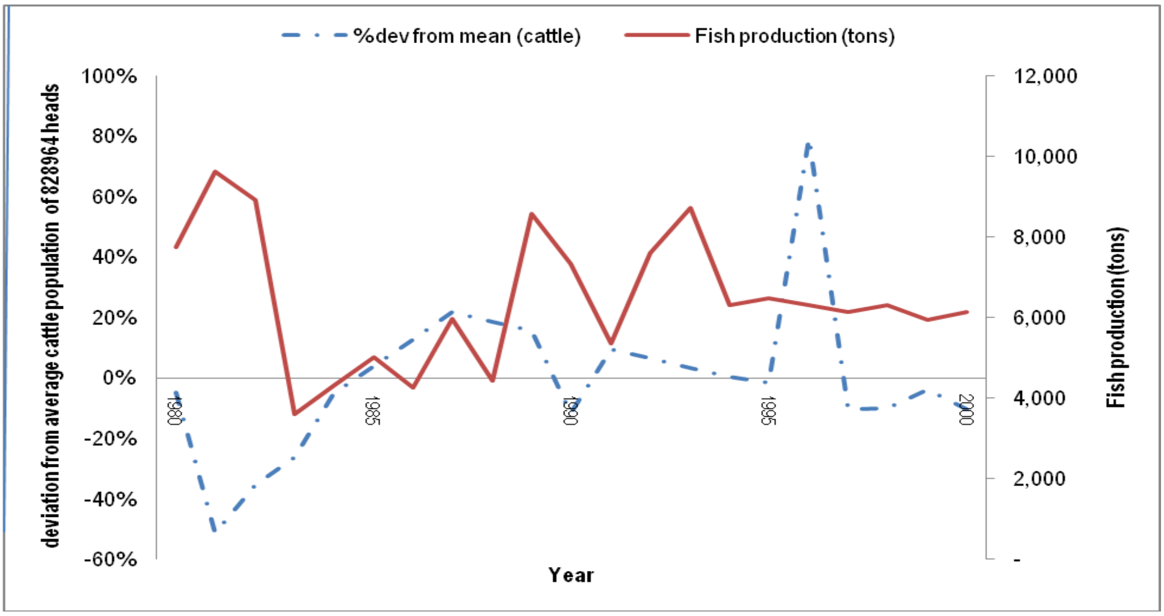

Figure 2.15: Inter-annual relationship between changes in cattle population and fish production in Kafue floodplain, 1980-2000

Figure 2.16 shows that fish, maize and cattle production per capita in Kafue floodplain had significant declining trends between 1980 and 2000 (t_{fish} = 4.392, $p < 0.001$; t_{maize} = 4.97, $p <$ 0.001; t_{cattle} = 4.769, $p < 0.001$, n = 21, respectively). Within this period, per capita fish, maize and cattle production had a negative correlation with human population (r = -0.535 for fish, r = -0.510 for maize and r = -0.372 for cattle; $p < 0.05$; n = 21) suggesting that the human population growth was higher than the production growth in fish, maize and cattle.

The per capita fish production has declined by about 64 per cent from around 14 kg per person per year in the 1980s to around 5 kg per person per year in 2000s while per capita maize production has declined by about 75 per cent from around 800 kg per person per year in the 1980s to around 200 kg per person per year in 2000s and per capita cattle heads has declined by about 50 per cent from around 1.2 heads per person per year in the 1980s to around 0.6 heads per person per year in the 2000s (Figure 2.16).

Figure 2.16: Inter-annual relationship between population growth and per capita fish (above), maize (middle) and cattle (below) production in Kafue flooodplain, 1980-2000

2.5 DISCUSSION

2.5.1 Socio-economic characteristics of households and fishing occupation

There were more specialised fishers than specialised farmers in the Kafue floodplain and a higher percentage of households participated in both fishing and farming (Table 2.1). The results concurred with earlier findings by DoF Zambia and CSO Zambia (2006) as well as WWF Zambia (2004). Fishing households had stayed in the floodplain for a shorter period of time as compared to specialised farmers (Table 2.1). Similar observations were also reported by Haller and Merten (2005). The open access nature of the Kafue floodplain fishery contributed to the influx of immigrant fishers especially after the collapse of the copper industry since most households who lost jobs in the formal sector resorted to fishing as an alternative source of livelihood. The influx of immigrant fishers was further propelled by relatively weaker enforcement of fishing regulations and low start-up capital and no need for prior experience to start fishing when compared to farming (WWF Zambia 2004). Soon after the collapse of the copper industry in Zambia, open access fisheries played a pivotal role as the immediate alternative source of livelihood to many jobless households. Consequently, most fisheries in Zambia including Lakes Kariba and Mweru experienced an increase in the number of immigrant fishers (Jul-Larsen *et al.* 2003). Similar responses to job losses by households have also been reported in Malawi in Lake Malombe (Jul-Larsen *et al.* 2003) and Lake Chilwa (Njaya 2002).

Fishing households had less land and fewer cattle than specialised farmers (Table 2.1) which was in line with their immigrant status since land and cattle acquisition in the Kafue floodplain is mainly through inheritance and inter-marriages (Haller and Merten 2005). The low ownership of land and cattle among fishing households was also associated with low income from farming, livestock and off-farm activities as compared to specialised farmers (Table 2.1). As a result, fishing was the main source of livelihood among immigrant fishing households in the Kafue floodplain. Other reviewers of natural resources in developing countries also contend that common property resources such as fisheries offer the main source of livelihood among rural poor households especially those with fewer assets (Béné 2006, Allison and Ellis 2001, ODI 2001, Ellis 2000). In particular, land and cattle are important assets in rural economies of sub-Saharan Africa since they distinguish the richer from the poorer households. Evidence from Ethiopia, Kenya, Malawi and Zambia also support this assertion (Jayne *et al*. 2006, Barrett 2005). The Kafue floodplain fishery therefore offers a livelihood option to asset poor households than could possibly be attained by pursuing other livelihood strategies. Similar roles have also been played by terrestrial natural resources in South Africa (Shackleton *et al.* 2008) and in Zimbabwe (Cavendish 2000).

Households participating in fishing had smaller land holding sizes, less income from livestock, shorter period of stay in the floodplain and higher level of household labour by men and women (Table 2.3) while the level of time spent fishing was jointly affected by smaller land holding sizes, fewer cattle owned and higher male and female labour (Table 2.4). The findings suggested that fishing households with less land and cattle but with more labour were likely to spend more time in fishing in the Kafue floodplain. The current findings were consistent with other findings on determinants of fishing effort in most artisanal fisheries in developing countries. For instance, Cinner *et al* (2008) found that fishing households with fewer resources in Kenya were less likely to reduce fishing effort or exit a severely declining artisanal coral reef fishery. Similar factors have also been found to determine fishing effort in artisanal fisheries in lakes and marine fisheries (Guillemot *et al*. 2009, Pollnac *et al*. 2008, Pollnac and Poggie 2006, Sesabo and Tol 2005, Geheb and Binns 1997).

Female members of fishing households in the Kafue floodplain also significantly participated in fishing activities. This observation was also echoed by Béné and Merten (2008) and Merten (2004) who found that female household members actively participated in fishing activities in the Kafue floodplain. Further, Malasha (2007) and Haller and Merten (2005) reported that female household members were involved in fishing especially during receding floods through group fishing in swamps and lagoons using baskets. The current observation on the role of female household members in fishing was therefore consistent with earlier findings in the Kafue floodplain.

2.5.2 The role of fishing as a source of income and animal protein

Fishing was the main source of income and animal protein consumption among households in the Kafue floodplain contributing about 51 per cent to total household income and about 56 per cent to animal protein consumption (Figures 2.2 and 2.3, respectively). The contribution of fishing to income and animal protein was especially higher among specialised fishers who earned about 77 per cent of their income from fishing and obtained about 63 per cent of their animal protein consumption from fishing. The findings demonstrated that there was heavy dependence on fishing particularly among specialised fishers and farming-fishers for income security and among the floodplain households including specialised farmers for animal protein security. Chirwa (2008) also found similar patterns with land among small-holder farmers in Malawi and related patterns have also been reported for small-holder farmers in Kenya, Mozambique and Zambia (Jayne *et al.* 2006).

High dependence on fishing though makes specialised fishing households vulnerable to environmental changes that affect fish stocks. Other studies also point out that higher reliance on a single source of income is usually associated with higher vulnerability to risks and poverty particularly in poorer households (FAO 2005, Ellis 2000, DFID 1999). The role played by fishing in the Kafue floodplain as the major source of animal protein security is nevertheless essential especially considering that the area has high prevalence of HIV/AIDS cases (Petersen 2007). For instance, Béné and Merten (2008) reported existence of *'fish-for-sex'* transactions in the Kafue floodplain which fuel HIV/AIDS cases. In that regard, fish may be the only readily source of income and cheaper source of animal protein available to the affected households in the floodplain. The income from fishing and the fish itself may be useful for AIDS-affected households, to buy medicines and to help maintain the health of people living with HIV and AIDS and those on ARVs. This has also been noted by WFC (2005), FAO (2005b) and NEPAD (2003).

Rising income from fishing was associated with higher expenditure on food, transport, education, loan servicing, farm inputs, household amenities and assets among fishing households in the Kafue floodplain (Table 2.5) implying that income from fishing made substantial contribution to household expenditure. This relationship between income from fishing and expenditure was expected since most fishing households relied heavily on fishing as the main source of income (Figure 2.2). The findings hold up to a number of literature characterising rural remote areas and natural resources (Béné *et al*. 2009, Ruben 2005, Bird *et al*. 2002, IFAD 2001, World Bank 2000). Most rural remote areas are characterised by low food production, high transaction costs, limited access to markets or lack of them, low provisioning of government services such as education and health facilities and lack of credit facilities (Ellis 2000). As a result, the major source of income offers the direct means of meeting household expenditure. Other studies in the Kafue floodplain have also underscored the higher transaction costs in the floodplain due to the isolated nature of the fishing camps and poor road infrastructure (Malasha 2007, Petersen 2007). This situation contributes to higher transport costs since households have to travel long distances often in poor road conditions to access social services such as clinics, markets and schools.

2.5.3 The role of fishing in alleviating income poverty

Income poverty was generally higher in fishing households although income from fishing contributed to lower rates of income poverty (Figure 2.4). Only fishing-farmers had a lower income poverty rate as a result of income from fishing when compared to specialised farmers. The findings also showed that income poverty rate was still higher among specialised fishers than among specialised farmers even when income from fishing was accounted for. The rate of poverty among specialised fishers was even higher than the 83 per cent poverty rate prevalence in rural Zambia and the 76 per cent poverty rate prevalence in the Southern Province of Zambia (CSO Zambia 2003). The results indicated that income poverty in the Kafue floodplain was rampant in predominantly fishing communities than in predominantly farming communities suggesting that fishing dependent households were relatively poorer than farming dependent households. The findings collaborated with poverty related literature in most small-scale fisheries describing fishing as the activity of last resort and fishers as the poorest of the poor (Bailey and Jentoft 1990, Panayotou 1982, Smith 1979). Small-scale fisheries such as inland floodplain fisheries are known to support significant numbers of resource poorer and landless households in most rural areas of the developing world (Allison 2004) as such small-scale fisheries are conventionally perceived to be positively correlated with poverty (see counterarguments in Béné 2009, Allison *et al*. 2006, Béné 2003).

The current findings implied that on average, households that spend a larger percentage of household time in fishing in the Kafue floodplain were worse-off in terms of income poverty relative to households in the Southern Province of Zambia and households in rural areas of Zambia. Thus, fishing households in the Kafue floodplain originally entered the fishery as the activity of last resort after job losses (Haller and Merten 2005) and therefore fishing households constitute the poorest of the poor households in the Kafue floodplain. The poverty condition of fishing households in the Kafue floodplain is further worsened by social exclusion of the fishing communities from government (provincial) social services (Malasha 2007). These circumstances have potential to create social traps that could confine fishing households to higher incidences of poverty than in other better serviced parts of the southern province. Social services such as education and health have been found to be significant in economic growth in sub-Saharan Africa and effectively contributing to attainment of MDGs (Baldacci *et al*. 2008). The current lack of such social services in the Kafue floodplain may destine fishing households in the Kafue floodplain to structural or chronic poverty (Béné 2009) with long-term repercussions on the sustainability of the fishery.

Both the income poverty gap and squared poverty gap significantly decreased with income from fishing implying that fishing in the Kafue floodplain reduced the depth and severity of poverty among fishing households (Figures 2.5 and 2.6). Although the incidence of poverty head count was higher among fishing households (Figure 2.4), the depth and severity of poverty was not statistically different from that of specialised farmers due to the effect of income from fishing.

The findings entailed that income from fishing played a critical role in reducing income inequality between fishing households and specialised farmers. Even though most fishing households lack assets, fishing provides a steady source of income which brings the depth and severity of income poverty to the same level as that of specialised farmers in the Kafue floodplain. Béné *et al*. (2009) also found that fishing was an important source of regular cash in remote areas of Congo DRC which serves as a *'bank in the water'* necessary for short-term cash needs. Results of similar nature have also been reported for Lake Chirwa in Malawi (Allison and Mvula 2002), Lake Kyoga in Uganda (Ellis and Bahiigwa 2003) and Lake Victoria in Kenya (Allison 2004, Geheb and Binns 1997).

2.5.4 The role of fishing in reducing economic vulnerability

Most studies related to analysis of vulnerability in small-scale fisheries demonstrate high vulnerability of fishing households (USAID Mozambique 2008, Allison *et al.* 2006, Ellis and Freedman 2005) and some have suggested that high vulnerability may be the root cause of poverty in most fishing communities (Béné 2009, Béné *et al.* 2003, Baulch and Hoddinott 2000). The results of economic vulnerability among fishing households of the Kafue floodplain showed that vulnerability was lower with fishing income than without fishing income (Figure 2.7). Fishing households had higher economic vulnerability than specialised farmers when income from fishing was not accounted for while specialised farmers displayed higher economic vulnerability than fishing households when fishing income was accounted for. The results underpinned the importance of fishing in the Kafue floodplain in reducing economic vulnerability. Despite the incidence of income poverty being higher in fishing households, economic vulnerability was lower than in specialised farmers when income from fishing was included in the analysis.

The current findings contradict some studies in small-scale fisheries that contend that low vulnerability is usually associated with low poverty (Barrett *et al*. 2006, Allison 2004, Béné *et al.* 2003). Besides the multidimensionality of both poverty and vulnerability (Booysen *et al*. 2008, Hoddinott and Quisumbing 2003, Chaudhuri *et al.* 2002), the current results show that poverty and vulnerability are not directly correlated in the Kafue floodplain. Whereas income poverty was still higher in fishing households with fishing income, economic vulnerability was lower than in specialised farmers suggesting that fishing households were poorer but not more vulnerable than specialised farmers. The present findings in the Kafue floodplain illustrate that regardless of the heavy dependence on fishing as the main source of income in fishing households, income from fishing reduced economic vulnerability but not income poverty.

2.5.5 The role of fishing as a social protection mechanism

Social protection mechanisms to help the poorest households are a priority in many developing countries (ODI 2001). However, the challenge is that most of the poor households in developing countries are involved in informal sectors such as subsistence farming and fishing that do not have statutory social insurance schemes. Also, in most rural remote areas such as those in which fishing communities are found, social assistance which is usually in form of health and education subsidy is lacking due to apparent absence of such social services. In much of the world where the rural poor depend upon the common property resources (floodplains, rivers, ponds, lakes, forests or scrub land) to meet many of their subsistence needs, or to obtain materials for sale, the commons can effectively be used to abate the high cost of social services including rising costs of food through income generated from harvesting the natural resources.

The estimates of social protection value of income from fishing in the Kafue floodplain showed that fishing generated almost US$ 0.56 per person per day in terms of poverty reduction and about US$ 1.13 per person per day in terms of vulnerability reduction (Figure 2.8). The social value of fishing in terms of poverty reduction was over half the nominal daily wage rate paid by large-scale farms such as sugar and coffee estates and above the rate paid by rich neighbours for casual work in 2003 (UNDP Zambia 2007). The current findings validated the importance of the Kafue floodplain fishery as a labour buffer and safety net mechanism (Table 1.1) in the rural economy of Zambia.

Unlike in high or middle income countries where national budgets can effectively support social protection interventions [see for instance the case of food subsidy in Indonesia (Dhanani and Islam 2002), the case of health insurance in China (Xiaoyi *et al.* 1999), the case of food for education in Bangladesh and Brazil (ODI 2001) and many other examples reviewed by ODI (2001)], low income countries like Zambia are financially constrained to provide social protection to most of the poorer households in rural areas. The Kafue floodplain fishery therefore plays a crucial role in cushioning the majority of fishing households from being below the poverty threshold that would have compelled them to seek social insurance and social assistance support from government (Table 1.1). This is an important function performed by floodplain fisheries on behave of national governments not only in Zambia but also in most parts of the developing world. Choice of management objectives of the Kafue floodplain fisheries (Figure 1.2) should therefore consider the social protection function performed by the fisheries.

2.5.6 Natural capital, accumulation of assets and social welfare of fishing

Understanding the link between natural capital such as fisheries and social welfare is a key concept in environmental economics (Brand 2009, Engelbrecht 2009, Barbier and Heal 2006) and a number of studies in ecological economics report a relationship between natural capital and social welfare (Bonini 2008, Brereton *et al*. 2008, Welsch 2007, Zidanšek 2007, Ferrer-i-Carbonell and Gowdy 2007, Brown and Kasser 2005). However, most of the studies establishing the link between natural capital and social welfare involve analysis at macro level and are hardly conducted in developing countries and rarely include fisheries as natural capital (Engelbrecht 2009). Engelbrecht (2009) argued that linking natural capital to well-being represents a new welfare economics of sustainability and as such limited data exists and data on other natural resources like fisheries, diamonds and subsoil water is usually lacking even in developed countries.

The current study contributes to the new welfare economics by demonstrating that longer stay in the floodplain by fishing households who rely on fishing as a natural capital leads to accumulation of assets such as land and cattle which have a direct positive impact on poverty reduction (Table 2.6). Reliance on natural capital such as fisheries over time effectively creates a springboard out of fishing by enabling accumulation of other livelihood assets and consequently enabling households to break the vicious cycle of poverty trap. The need to broaden the analysis of natural capital and social welfare in developing countries and at micro-level in the context of the new welfare economics of sustainability cannot be overemphasised especially considering that fishing plays an important role in reducing economic vulnerability in the Kafue floodplain.

The new welfare economics of sustainability would also prove important points regarding causes of poverty and vulnerability in fishing communities of Kafue floodplain: whether poverty and vulnerability are caused by external factors affecting the entire floodplain community or by internal factors related to fishing occupation or both (Béné 2003, Hardin 1968, Gordon 1954). So far, evidence from the Kafue floodplain suggests that fishing communities are poorer but are less vulnerable than farming communities (Figures 2.4 and 2.7). The isolated nature of the fishing camps and the lack of social services including fewer sources of income are largely blamed for higher rates of poverty among fishing households in the Kafue floodplain while the nature of fishing as an occupation which accords fishing households regular cash income is partly responsible for the low level of economic vulnerability in Kafue floodplain.

The current findings also demonstrated that instead of fishing households being confined to the fishing camps through social traps, fishing provided escape mechanism out of the fishing camps by building livelihood capabilities through asset accumulation (Sen 1987). The recent findings were contrary to other studies that found that poor people are unable to mobilise the necessary resources to overcome either shocks or chronic low-income situations and therefore remain in poverty (Cinner *et al*. 2008, Barrett *et al*. 2006, Carter and Barrett 2006, Adato *et al*. 2006, Dasgupta 1997, Costanza 1987).

While it is true that in situations where fishing is a choice and not purely a necessity, and hence some fishers will still remain in fishing despite declining fish stocks and availability of exist mechanisms (Cinner *et al.* 2008), the Kafue floodplain scenario represented the later situation to a large extent. In the Kafue floodplain, income from fishing may be regarded as one of the push-factors necessary for escaping poverty traps (Bloom *et al*. 2003). The move out of the fishing camps is further enhanced through intermarriages between the immigrant fishers who have farming skills but no land and indigenous pastoralists who have land but lack farming skills (focus group discussions). The hybrid families prefer to stay in the mainland where they farm, rear cattle and access the fishery while also being in proximity to social services such as schools, clinics and better roads than in the fishing camps. Consequently, reliance on income from fishing declines with increasing accumulation of land and cattle (Table 2.6).

2.5.7 Relationship between inter-annual rainfall, fisheries and agricultural production

Both fisheries and agricultural production in the Kafue floodplain display a worsening situation that would potentially jeopardise the livelihoods of the floodplain communities. The findings showed that, annual fish production has declined since the late 1980s. Likewise, annual maize production and cattle population have also declined, and so too were the per capita production levels of fish, maize and cattle (Figures 2.10-2.16). The decline in fish production in Kafue floodplain could be explained by a number of factors including but not limited to overfishing due to high influx of fishers, the effects of damming of the Kafue river and the effects of high rainfall variability with frequent droughts between 1990 and 1995 (Roosmalen 2004, CEH Zambia 2001).

A range of other studies related to fish production in floodplains also indicate that the environment and flooding regimes have significant positive correlation with fish production (Nyimbili 2006, Chimatiro 2004, Jul-Larsen *et al.* 2003, Kolding 1994, Laë 1994, Lowe-McConnell 1979, Welcomme 1974). Laë (1994) found that droughts and construction of electric power dams in Niger River modified the biological cycle of the fish replacing the former species with smaller, short life cycle, high fecundity and high mortality species. Similar observations have also been reported in the Kafue floodplain (Nyimbili 2006) and the Lower Shire floodplain (Chimatiro 2004).

Given that the growth of the population in the Kafue floodplain and that both maize and cattle production largely follow a traditional inheritance system of land and livestock, respectively, the open access nature of the Kafue floodplain fishery will continue to attract households with insecure land titles and outside the traditional cattle inheritance system affected by the deteriorating productivity of the agricultural sector. In addition, since the costs of entering the fishery are low with relatively high returns and entry does not require prior experience, this will further provide incentives to new households to enter the fishery thereby increasing fishing pressure (Allison and Ellis 2001). Geheb and Binns (1997) showed that with increasing pressure on land due to population growth, fishing played an important role in supplementing declining per capita food production, and providing additional cash income to rural poor households in Kenya's Lake Victoria fishery. The Kafue floodplain fishery situation may not be different from the Lake Victoria fishery scenario.

The scenario in the Kafue floodplain should inform the way in which the fishery should be managed in order to secure future availability of welfare function performed by the fishery. As observed in figures 2.10 and 2.16, existing fisheries management strategies in the Kafue floodplain might not reverse the declining trend in fish production which might negatively impact on the contribution of fisheries to livelihoods and welfare in the long-run. The fish production trend is likely to worsen in the long-term due to imminent high rainfall variability as a result of El Niño/La Niña conditions and episodes which would continue affecting rainfall pattern (NCDC 2009) and consequently the value of natural capital to social welfare (Heal 2008).

In view of this, the trade-off between limiting access to the fishery in order to resuscitate fish stocks against *'liberalised'* access to the fishery in order to maximise welfare function of the fishery to households have to be critically examined within the broader context of climate change, rural development, poverty and vulnerability reduction. It is also important to bear in mind that for the rural poor, environmental resources such as fisheries can supplement income and consumption especially in times of economic stress (Islam and Braden 2006) such that continuing degradation of the environment either by natural or human circumstances only serves to worsen the poverty situation of rural households (Dasgupta and Mäler 1997). Islam and Braden (2006) further pointed that better management of river floodplains where fisheries are considered alongside agricultural development would be essential for realizing the long-term economic benefits of ecosystems, particularly in low income countries.

2.6 SUMMARY

The current study builds on a number of previous studies related to poverty and vulnerability in fishing communities (Béné 2009, Barrett *et al.* 2006, Ellis and Freedman 2005, Béné 2003, Béné *et al*. 2003, Allison and Mvula 2002, Allison and Ellis 2001, Geheb and Binns 1997). Unlike the previous studies, the present study emphasised on the need to understand the socioeconomic context of the fishing communities in order to determine factors that influence time spent fishing. Smaller land holding sizes and fewer cattle were found to be associated with more time spent fishing in the Kafue floodplain. Fishing in the Kafue floodplain serves as a safety net to households that lost jobs in the formal sector and as a labour safety valve to households with fewer assets and sources of income (Table 1.1; Béné 2006). These socioeconomic factors should be taken into account when designing management strategies for recovery of the Kafue floodplain fishery (Figure 1.2).

This study is also distinct from the other studies related to poverty and vulnerability in fishing communities. The recent study assesses poverty and vulnerability in fishing communities using *'with and without'* fishing income scenarios thereby directly demonstrating the welfare value of fishing. The study demonstrated that income from fishing was necessary in alleviating poverty but was not sufficient enough in reducing poverty while it was significant in reducing economic vulnerability among fishing households in the Kafue floodplain. The study provides evidence that poverty and vulnerability are not directly correlated in the Kafue floodplain. While specialised fishing households were found to be poorer than specialised farming households, the contrary was true for economic vulnerability.

Additionally, the assessment of poverty and vulnerably also embraced the *social protection* concepts (Table 1.1), making it one of the few studies in small-scale floodplain fisheries that link the welfare value of floodplain fisheries to social protection. The social protection value of income from fishing was equivalent to about a third of the minimum daily wage rate paid by large estates and almost the same as the minimum daily wage paid by rich neighbours in the Kafue floodplain. In this sense, the Kafue floodplain fishery is effectively subsidising government expenditure on social protection by providing regular cash income to fishing households. The study also showed that with longer stay in the floodplain and reliance on income from fishing, households accumulate assets over time. These assets provide building blocks out of the fishery and out of poverty trap thereby relieving fishing pressure. These welfare and social protection functions performed by the Kafue floodplain fishery should be given prominence when designing programmes for rural development and poverty reduction in the Southern Province of Zambia.

The present study also assessed the relationship of fisheries and agricultural production with local rainfall. Rainfall variability is a real threat to poverty and vulnerability reduction in most developing countries that depend on rain-fed agriculture and attempts to show how the poorer and marginalised households would be affected by rainfall variability are of great interest particularly in floodplains where fish production is directly linked to water level. The current assessment in the Kafue floodplain showed that local rainfall variability affected fish production alongside other factors such as overfishing, use of destructive fishing gear and poor fisheries management. Empirical evidence also shows that the effect of rainfall variability on fish production is worsened by damming of the river system which changes the flooding regime (Nyimbili 2006). Fish production in Kafue floodplain has therefore declined over the years.

The situation in agriculture is equally not impressive. Both maize production and cattle population have declined. The analysis demonstrated that livelihood strategies in the Kafue floodplain were under threat. When designing fisheries management strategies for the Kafue floodplain, it is important to recognise these trends especially those in agriculture since worsening conditions in agricultural sector were likely to result in potentially more households entering the fishery thereby stressing further the fishery besides the effects of environmental and climatic conditions.

1. Dugout canoes (main fishing gear)

2. A typical fishing village

CHAPTER THREE: THE LOWER SHIRE FLOODPLAIN FISHERIES IN MALAWI

3.1 INTRODUCTION

Malawi is a land locked country with a total area of approximately 118,900 km^2 of which 20 per cent is covered by water bodies. It is one of the world's poorest countries ranked 164 out of 177 countries on the Human Development Index in 2007 (UNDP 2007). Poverty is widespread and deep and about 65 per cent of Malawians lived below the national poverty line between 1990 and 2004 (UNDP 2007). Agriculture, which includes fisheries and forestry, is the main driver of Malawi's economy, accounting for 36 per cent of GDP, 87 per cent of total employment and 65 per cent of total income of the rural poor (GoM 2006).

Fisheries provide a source of direct employment to about 48,000 people and indirectly employ about 230,000 people (Bulirani *et al.* 1999). Fish has been the main source of animal protein in Malawi, accounting for approximately 60 per cent of total supply but per capita animal protein intake has fallen by 40 per cent, from 6.6 g per day in 1971 to 3.7 g in 2001 (FAO 2005). The decline in animal protein intake is directly related to per capita fish supply, which has declined from 12.8 kg per year during the early 1970s to 5.8 kg in 2005 (JICA and GoM 2005).

The overall objective of this chapter is to assess the welfare value of the Lower Shire floodplain fisheries in alleviating rural poverty and vulnerability in Malawi. Specifically, the chapter:

1. Assesses the socio-economic factors affecting the decision to participate in fishing and level of time spent fishing in the Lower Shire floodplain.
2. Evaluates the relationship between fishing income and expenditure on various items by fishing households in the Lower Shire floodplain.
3. Investigates the contribution of fishing to poverty and vulnerability reduction in fishing households of the Lower Shire floodplain.
4. Evaluates the seasonal relationship between farming and fishing in the floodplain.
5. Determines the inter-annual relationship between local rainfall, fisheries and agricultural production.

3.2 STUDY AREA

3.2.1 Location and extent

The Lower Shire floodplain is located between 14°25'-17°50'S and 35°15'-35°20'E and is the only outlet of Lake Malawi (Figure 3.1).

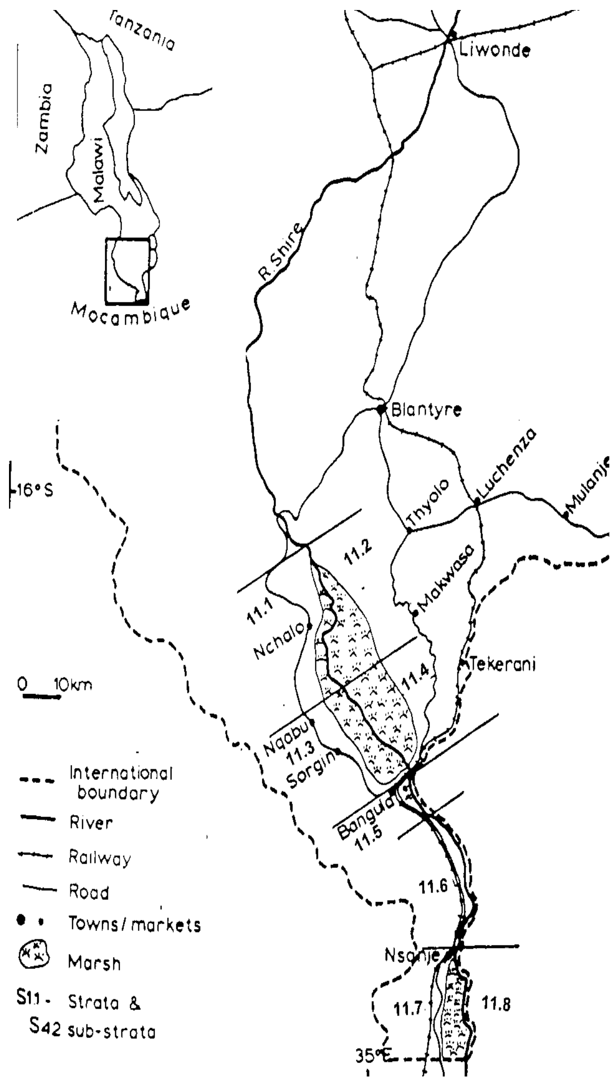

Figure 3.1: Map of the Lower Shire floodplain

Source: Njaya (2007)

From Lake Malawi, the river meanders southwards for a distance of approximately 700 km to its confluence with the Zambezi River. About 95 per cent of the Shire River is situated in Malawi and the rest in Mozambique. The Shire River is generally divided into three sections: the upper, middle and lower section (Tweddle *et al*. 1979).

The lower section covers Chikwawa and Nsanje districts and extends from Kapichira falls to the end of Ndindi marsh on the border with Mozambique (Timberlake 1997) and includes the floodplain system characterised by the Elephant, Eastern and Ndindi marshes (Chimatiro 2004). The Lower Shire, and associated floodplain wetlands cover about 6,700 km^2 (Turpie *et al.* 1999). The climate of Lower Shire is characterised by relatively low and fairly variable rainfall ranging from 560 mm to 960 mm per annum, which largely occurs between December and January. Temperature is mild to hot ranging from 25°C to 33°C. The floodplain has four quarterly hydroclimatic seasons: hot, dry weather with a low flood regime (July to September); hot, windy, wet weather with low but rising flood regime (October to December); hot, humid, wet weather with peak flood (January to March) and humid and cool weather with receding flood (April to June) (Chimatiro 2004).

3.2.2 Livelihoods in the Lower Shire floodplain

The Lower Shire floodplain has a population of about 677,000 people (NSO Malawi 2008). The area is inhabited by a mixture of tribes that undertake a number of livelihoods mainly farming, fishing and livestock rearing (NSO Malawi 2005). The floodplain also hosts one of the major irrigated sugar estates in Chikwawa and a number of game reserves outside the floodplain that offer formal employment to some of the local people (Turpie *et al.* 1999). There are also major hydro-electric power generation stations on Shire River which are located in the middle section of the river that also provide some formal employment to the local people. Damming of the river for water flow regulation for the hydro-electricity generation was done upstream of the floodplain in the middle section and has been found not to have significant effect on fish production in the Lower Shire floodplain (Chimatiro 2004). There are about 150,000 households in the area covered by the Lower Shire floodplain (NSO Malawi 2008). About 53 per cent of the households were reported to undertake fishing or fishing related activities in 1998 (Turpie *et al.* 1999).

Chikwawa district is connected by the all season M1 road that links the district with Blantyre city, the largest commercial city of Malawi. The government of Malawi is also currently extending the M1 road to Nsanje which would significantly increase volume of business between the district and Blantyre city. The Lower Shire floodplain is considered a food basket for the commercial city in terms of food crops, livestock products and fish (GoM 2005).

3.2.3 Fisheries of the Lower Shire floodplain

The fishery is typically small-scale and largely uncommercialised, with fishers using mainly dugout canoes and three main types of gear (gillnets, castnets and fishtraps) which account for about 83 per cent of total catch by mass. The bulk of the catch is made up of *Clarias gariepinus* and *Oreochromis mossambicus* (Chimatiro 2004). The biology of the fish species is characterised by high fecundity, rapid growth and development, high natural mortality and generalised feeding behaviour. The populations contain relatively few year classes, short life cycles and generation turnover is fast (Kvist and Nebel 2001, Welcomme 2001). The productivity of the fisheries is therefore highly dependent on the floodplain regime which is determined by rainfall and other environmental conditions (Chimatiro 2004). Fish production from the Malawi section of the Lower Shire floodplain ranged from 1,400 tons to 3,000 tons between 1991 and 2005 (JICA and GoM 2005). The fishery is therefore considered important in the local economy in terms of animal protein nutrition and household cash income.

Due to relatively good road network to the commercial city of Blantyre and the tea estates in Thyolo and Mulanje, fish demand is relatively high among resource poor households compared to livestock meat (Chimatiro and Mwale 1998). The 'high' demand for fish in the upland areas attracts local people in the Lower Shire Valley to enter the fishery in order to supply the fish to the upland areas (Chimatiro and Mwale 1998). The fishing communities (and in particular the poorest and most marginalised) rely to a large extent on aquatic resources and fisheries-related activities to sustain their livelihoods and improve their food and nutritional security. Future provisioning of these livelihood functions by the fisheries would strongly depend on innovative management practices that would reverse the declining trend in capture fisheries.

3.2.4 Management of the Lower Shire floodplain fisheries

The fishery is administratively managed by the Department of Fisheries (DoF) in the Ministry of Agriculture and Food Security and also through community participation (GoM 2001, Njaya 2007). Fisheries management is concerned with fishing gear licensing and restriction of mesh size of fishing nets. The fishery is formally in a state of open access with no closed season but local institutions have informal mechanisms that restrict entry into the fishery (Bulirani *et al.* 1999, Njaya 2007).

The development process for legislative and policy frameworks supporting community participation in fisheries management in Malawi took place between 1997 and 2001 (DoF

Malawi 2006). As a result, participatory fisheries management is legally recognised by the Fisheries Act. Fishers contribute to decisions regarding rules governing the resource management of the floodplain to supplement regulations formulated by DoF Malawi. The regulations mainly relate to setting of weirs with one-third gap, ban on mosquito nets and prohibiting use of poisonous plants for fishing. The local leaders and Beach Village Committees (BVCs) also set customary sanctions on the ban of mosquito nets and fish poisoning (Njaya 2007). Fishing gear licensing, mesh size restriction and maximum headline of the fishing nets are still the responsibilities of DoF Malawi (DoF Malawi 2006). The interaction regarding natural resource management between fisheries sector and other natural resource related sectors such as environment, agriculture, water, wildlife, transport and forestry is minimal leading to conflicting policy agendas (Njaya 2007).

In principle, the fishery is open access but local leaders set rules that prevent immigrants to be directly involved in fishing. Immigrants are only allowed as fish traders who are known as *'angoni'* which literally means *'immigrant'*. There are also territorial private rights by local fishers in the fishing grounds (key informant interviews). These conditions have however been reviewed through BVCs although there is apparent tension between BVC committee leaders and traditional leaders on who gets the fishing access 'fees' (Njaya 2007).

3.3 METHODS

3.3.1 Survey design

Reconnaissance surveys were conducted using focus group discussions and key informant interviews (Appendix A). These were conducted in order to understand the different stakeholders, livelihood strategies and interaction between fishing and other activities in the floodplain as well as the impact of changes in rainfall pattern on fisheries and agricultural production. The information was also used in framing of questions for the household surveys. In the household surveys, data was collected using a household questionnaire (Appendix B). The type of data collected in the household survey was in the context of livelihood assets and included but not limited to human capital such as age, education, length of residence in the floodplain and household size; natural capital such as land, livestock and fish stock; physical capital such fishing gear, fishing craft, tools and equipment; financial capital and income from livelihood strategies such as fishing, farming, livestock and off-farm activities; expenditure on food and non-food items; exposure to risks and coping mechanisms adopted.

3.3.2 *Sampling strategy*

The Lower Shire floodplain is divided into Agricultural Extension Areas (EPAs) which are the lowest administrative units for agricultural extension and management under the Ministry of Agriculture and Food Security (MoAFS) in Malawi (MoAFS 2006). The Department of Fisheries (DoF) falls under MoAFS and uses the stratum as the lowest administrative unit for fisheries extension and management. The strata cover the same geographical area in the floodplain as the EPAs. The strata extend laterally away from the river to the border with Mwanza and Blantyre districts in the north, Thyolo district in the eastern side and Mozambique border to the east, west and south. The strata encompass the population that potentially has access to the fishery in the floodplain (DoF Malawi 2006; Figure 3.1). A household was the sampling unit for the survey. Lists of households in each village within the floodplain were obtained from agriculture and fisheries offices which were later verified and updated during key informant interviews and focus group discussions. A random sampling strategy was used to draw households in the villages in the floodplain. In each village, households were randomly sampled every month from January 2008 to December 2008. For each month, new households were randomly drawn and interviewed.

3.3.3 *Data collection*

Household data was collected using a survey questionnaire (Appendix B) which was administered by seven research assistants who covered all the strata in the entire floodplain. Prior to the survey, the research assistants were trained and also pre-tested the questionnaire during the training. About 112 households were randomly sampled every month for twelve months resulting in a total sample of 1,344 independent households. The household questionnaire had a mixture of closed and open-ended questions. The questionnaire was in English but the interviews were conducted in local language. Measurements were reported in local and commonly used units which were later converted to standard units such as hectare[12] (ha) and kilogram (kg). Income and expenditure were reported in local currency of Malawian Kwacha (MK) which was later converted to United States dollars (US$) using the average monthly exchange rate from the Reserve Bank of Malawi (RBM). For the period under the survey, the average exchange rate was 1 US$ ≈ MK 141[13].

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[12] 1 ha ≈ 2.4 acres (NSO Malawi 2005).

[13] Accessed from Reserve Bank of Malawi at http://www.rbm.mw in March, 2009.

Times series data was collected using desk reviews of secondary sources that mainly included government documents (Appendix C). Local rainfall data was collected from the department of meteorological services. Rainfall data was recorded in millimetres (mm). The data that was collected in inches was converted to millimetres at the rate of 1 inch equivalent to 25.4 mm (WMO 1988). The meteorological department in Malawi is part of the World Meteorological Organisation (WMO) network; thus, the recording procedures are accredited by and comply with the technical regulations specified by the WMO on climate (WMO 1988). Data covered the period between 1986 and 2005.

Fish production data was collected from DoF Malawi (2006). Fish production was recorded in tons using methods developed by Bazigos (1974) as revised by Willoughby and Walker (1978) which use monthly catch assessment and annual frame surveys. However, the catch assessment survey has been observed as not suitable for floodplain fisheries as the method does not take into account the uneven distribution of fishing gear in floodplain fisheries (Alimoso 1994). Nonetheless, no alternative method has been put in place and fisheries management decisions still depend on the available data collected using the existing methods. Data covered the period from 1986 to 2005.

Long-term data on maize production and cattle were collected from the planning department in the Ministry of Agriculture and Food security in Malawi. Maize production was recorded in metric tons. The data collection methods for maize and cattle conform to established international standards on agricultural statistics for crop and livestock estimates (FAO 2005b). The data covered the period from 1986 to 2005.

Population data was collected from national statistical office in Malawi. For years without reported population figures, these were estimated using inter-census population growth rate as reported by the national statistical office. The statistical office in Malawi complies with established international standards on population census (UNDP 1999). Data covered the years between 1986 and 2005.

3.3.4 Data management

Data entry was done in Microsoft Excel 2007 spreadsheet and data cleaning was conducted using pivot tables and scatter plots. Data cleaning involved removing incomplete questionnaires and households with outlier values. Outliers were identified by physically examining the data points on scatter plots and those that were above or below three standard deviations. After removing households with outlier values, a total of 1,044 households were used in the final analysis which was conducted in Statistical Package for Social Scientists (SPSS) 17.0.

3.3.5 Data analysis

The chapter used data analysis methods described in Chapter 2, section 2.3.5 to 2.3.10 except for the national poverty line which was estimated at MK42 per person per day in Malawi.

3.4 RESULTS

3.4.1 Socio-economic characteristics of households in the Lower Shire floodplain

About 69 per cent of the sample households were specialised farmers, 18 per cent were fishing-farmers, 13 per cent were farming-fishers and no specialised fishers (Table 3.1). Specialised farmers had the smallest household size, fewest years of formal education and less time worked by male members than female members ($p < 0.001$; Table 3.1); fishing-farmers had the largest household size, oldest heads of households, longer stay in the floodplain and more household labour contributed by male members than female members ($p < 0.001$, $p < 0.01$; Table 3.1) while farming-fishers had younger heads of households, highest years of formal education, shorter residence in the floodplain and least time worked by female household members than male members ($p < 0.001$, $p < 0.001$; Table 3.1).

Specialised farmers had the largest land holding size while farming-fishers had the smallest land holding size ($p < 0.001$; Table 3.1) and number of cattle owned was not significantly different across household groups ($p > 0.05$; Table 3.1). Household income was lower among specialised farmers and was higher among farming-fishers ($p < 0.001$; Table 3.1). Farming-fishers had the highest income from fishing, farming, livestock and off-farm activities than the other household groups ($p < 0.001$, $p < 0.01$; Table 3.1).

Table 3.1: Comparison of socio-economic characteristics of household groups in the Lower Shire, 2008

		Specialised fishers[a]	Farming-fishers[b]	Fishing-farmers[c]	Specialised farmers[d]	F-test (across groups)
	n	0	141	183	720	
Household demographics:						
HH size (# of persons):						
	Mean		5.0	5.9^{b**,d***}	4.9	F = 13.223,
	SE		0.15	0.16	0.08	$df = 2, 1041$; $p < 0.001$
Age of HH head (years):						
	Mean		37.1	41.4	41.1	F = 7.12,
	SE		0.86	0.83	0.46	$df = 2, 1041$; $p < 0.01$
Education of HH head (years):						
	Mean		5.2	4.1	3.4	F = 10.937,
	SE		0.32	0.26	0.13	$df = 2, 1041$; $p < 0.001$
Length of residence (years):						
	Mean		22.5	28.3	27.5	F = 6.269,
	SE		1.34	1.18	0.61	$df = 2, 1041$; $p < 0.01$
Male labour per month (hours)						
	Mean		152.8^{d***}	163.1^{d*}	90.7	F = 58.924,
	SE		7.48	6.87	3.54	$df = 2, 1041$; $p < 0.001$
Female labour per month (hours)						
	Mean		64.7^{cd***}	143.5^{d***}	119.9	F = 30.222,
	SE		3.16	7.2	3.67	$df = 2, 1041$; $p < 0.001$
Household assets:						
Land holding size (ha):						
	Mean		1.01^{c,d***}	1.12^{d*}	1.19	F = 4.632,
	SE		0.04	0.05	0.02	$df = 2, 1041$; $p < 0.05$
Number of cattle (heads):						
	Mean		0.62^{d**}	0.56	0.50	F = 0.326,
	SE		0.13	0.15	0.67	$df = 2, 1041$; n.s.
Household income:						
Total income per month (US$):						
	Mean		260.90	252.14	85.23	F = 73.719,
	SE		21.23	12.08	5.08	$df = 2, 1041$; $p < 0.001$
Fishing income per month (US$):						
	Mean		122.31^{c*,d***}	62.34^{d***}	0.0	F = 262.96,
	SE		11.2	6.8		$df = 2, 1041$; $p < 0.001$
Farming income per month (US$):						
	Mean		86.40^{d***}	66.15^{d*}	55.49	F = 4.876,
	SE		12.05	7.78	3.84	$df = 2, 1041$; $p < 0.01$
Livestock income per month ($):						
	Mean		19.10^{d**}	10.75	12.13	F = 1.283,
	SE		4.53	1.59	2.07	$df = 2, 1041$; $p < 0.01$
Off-farm income per month (US$):						
	Mean		33.09^{d***}	11.32	17.61	F = 9.878,
	SE		6.19	2.65	1.46	$df = 2, 1041$; $p < 0.001$

df = degrees of freedom, n.s. = not significant, *F*-test based on one way ANOVA, SE = Standard Error.
*The superscripts show one way ANOVA Post-Hoc tests for pairwise comparison of means based on Sidak statistic. Only significant pairwise mean comparisons are shown by letters a, b, c and d which represents the household groups, respectively. * = significant at p < 0.05, ** significant at p < 0.01 and *** = significant at p < 0.001.*

3.4.2 Socio-economic factors related to participation in fishing and level of time in fishing

The results indicated that time spent fishing in the Lower Shire floodplain was negatively correlated with land holding size while household size and income from off-farm activities were positively correlated with time spent fishing per month (Table 3.2). The results suggested that more household time was allocated to fishing in household with less land holding size, more household labour and more income from off-farm activities.

Table 3.2: Linear relationships between level of time in fishing and related socio-economic factors in Lower Shire floodplain, 2008.

Dependent variable: Time spent fishing per month (hours) against:	**Standardised b**	**R^2**	***p***
Total land holding size (ha)	-0.084	0.007	<0.01
Household size (# of persons)	0.09	0.008	<0.01
Off-farm income per month (US$)	0.084	0.007	<0.01

n = 1044

Table 3.3: Results of multiple regression analysis on the socio-economic factors related to participation in fishing in the Lower Shire floodplain, 2008

	OLS Enter method		**OLS Stepwise method**	
Dependent: Time spent fishing per month (hours)	**Standardised Coefficient**	**t-statistic**	**Standardised Coefficient**	**t-statistic**
Land holding size (ha)	-0.145	-4.781***	-0.143	-5.149***
Number of cattle owned (heads)	-0.03	-0.988		
Length of residence (years)	-0.033	-1.72		
Household size (# of persons)	0.005	0.15		
Age of household head (years)	-0.036	-1.057		
Education of household head (years)	0.031	1.084		
Farming income per month (US$)	0.052	1.744		
Livestock income per month (US$)	0.007	0.23		
Off-farm income per month (US$)	0.087	3.088**	0.089	3.224**
Labour by male members per month (hours)	0.482	16.024***	0.482	16.923***
Labour by female members per month (hours)	-0.105	-3.403**	-0.121	-4.427***
F statistic	***28.587****		***61.46****	
df	***11, 1032***		***5, 1038***	
R^2	***0.234***		***0.228***	
Adjusted R^2	***0.225***		***0.225***	

n = 1044, OLS = Ordinary Least Squares, = significant at p < 0.05, ** = significant at p < 0.01, *** = significant at p < 0.001.*

Multiple regression analysis was used in order to account for interaction between factors and to determine factors that jointly affected the decision to participate in fishing among fishing households in the Lower Shire floodplain. The results in Table 3.3 showed that the decision to participate in fishing had significant negative relationship with land holding size ($p < 0.001$) and labour from female members ($p < 0.001$) and was positively correlated with labour from male household members ($p < 0.001$) and income from off-farm activities ($p < 0.01$). The goodness of fit ($R^2 = 0.23$) was poor but significant ($p < 0.001$, Table 3.3).

The results in Table 3.4 showed that the level of time spent fishing had significant positive relationship with household size ($p < 0.01$), with labour from male members ($p < 0.001$) and income from off-farm activities ($p < 0.01$). The goodness of fit was also significant ($p < 0.001$) and the normality assumptions were not seriously violated (Appendix F2).

Table 3.4: Socio-economic factors affecting the level of time spent fishing in the Lower Shire floodplain, 2008

	OLS Enter method		**OLS Stepwise method**	
Dependent: Time spent fishing per month (hours)	**Standardised Coefficient**	**t-statistic**	**Standardised Coefficient**	**t-statistic**
Land holding size (ha)	-0.078	-1.449		
Number of cattle owned (heads)	-0.013	-0.266		
Length of residence (years)	-0.02	-0.377		
Household size (# of persons)	0.085	1.62	0.133	2.826**
Age of household head (years)	-0.026	0.442		
Education of household head (years)	-0.034	-0.692		
Farming income per month (US$)	0.018	0.359		
Livestock income per month (US$)	0.062	1.274		
Off-farm income per month (US$)	0.116	2.45*	0.129	2.811**
Labour by male members per month (hours)	0.595	12.135***	0.566	12.04***
Labour by female members per month (hours)	-0.084	-1.609		
F statistic	***14.885****		***51.611****	
df	***11, 312***		***3, 320***	
R^2	***0.344***		***0.326***	
Adjusted R^2	***0.321***		***0.32***	

n = 324, OLS = Ordinary Least Squares, = significant at p < 0.05, ** = significant at p < 0.01, *** = significant at p < 0.001.*

3.4.3 *Contribution of fishing to income and animal protein*

The mean proportion of total household income provided by fishing decreased from farming-fishers to specialised farmers while that provided by farming and livestock increased from farming-fishers to specialised farmers (Figure 3.2). There was no clear pattern for the mean proportion of income from off-farm activities across household groups but specialised farmers had higher proportion of total household income from off-farm activities (Figure 3.2). The mean proportions of income to total household income from fishing, farming and off-farm activities were statistically different across household groups ($F_{fishing\ (2,\ 1041)} = 1063.17$, $p < 0.001$; $F_{farming\ (2,\ 1041)} = 43.494$, $p < 0.001$; $F_{off\text{-}farm\ (2,\ 1041)} = 58.683$, $F_{livestock\ (2,\ 1041)} = 1.86$, $p > 0.05$; Figure 3.2).

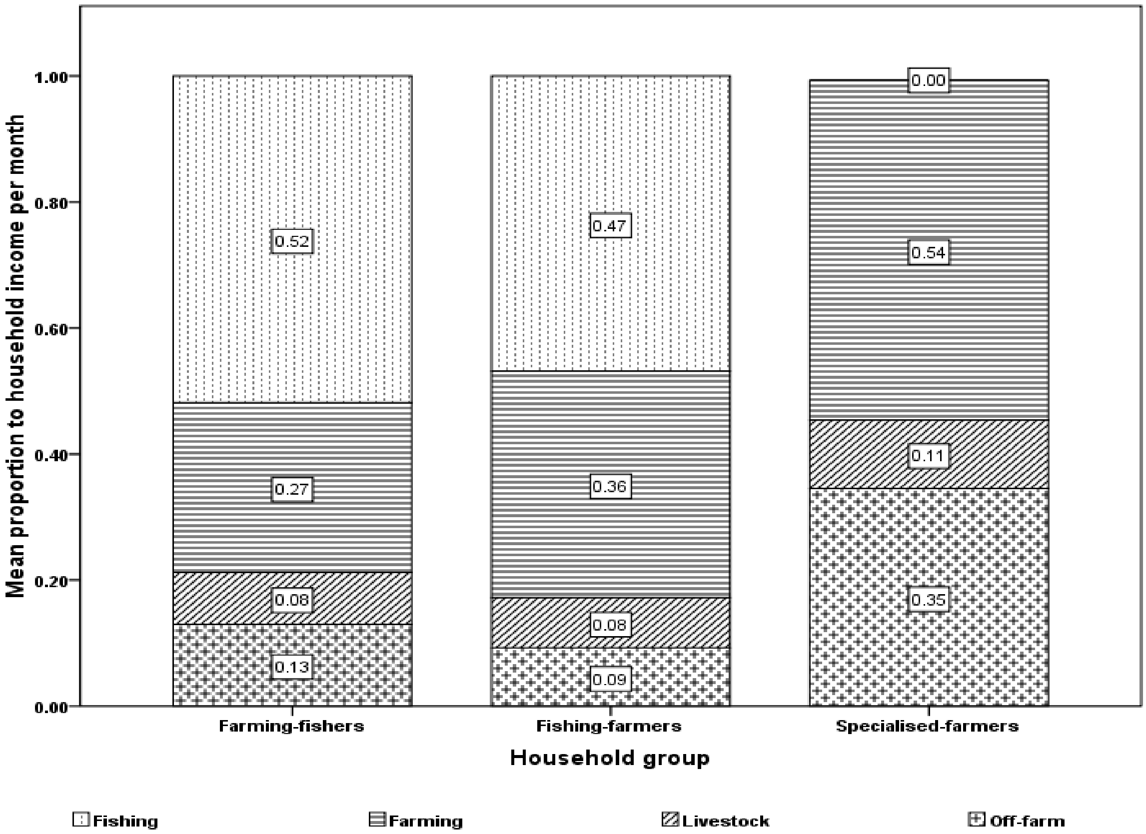

Figure 3.2: Mean proportional contribution of main sources of income to total household income per month across household groups in the Lower Shire floodplain, 2008.

The average proportional contribution of fish to animal protein (meat, fish and milk) consumption per month increased from farming-fishers to specialised farmers while that of meat and milk decreased from farming-fishers to specialised farmers (Figure 3.3). The mean proportional contribution per month of fish and meat to animal protein consumption were statistically different across household groups ($F_{fish\ (2,\ 1041)} = 5.985$, $p < 0.01$; $F_{meat\ (2,\ 1041)} = 6.069$, $p > 0.01$; $F_{milk\ (2,\ 1041)} = 0.405$, $p > 0.05$; Figure 3.3).

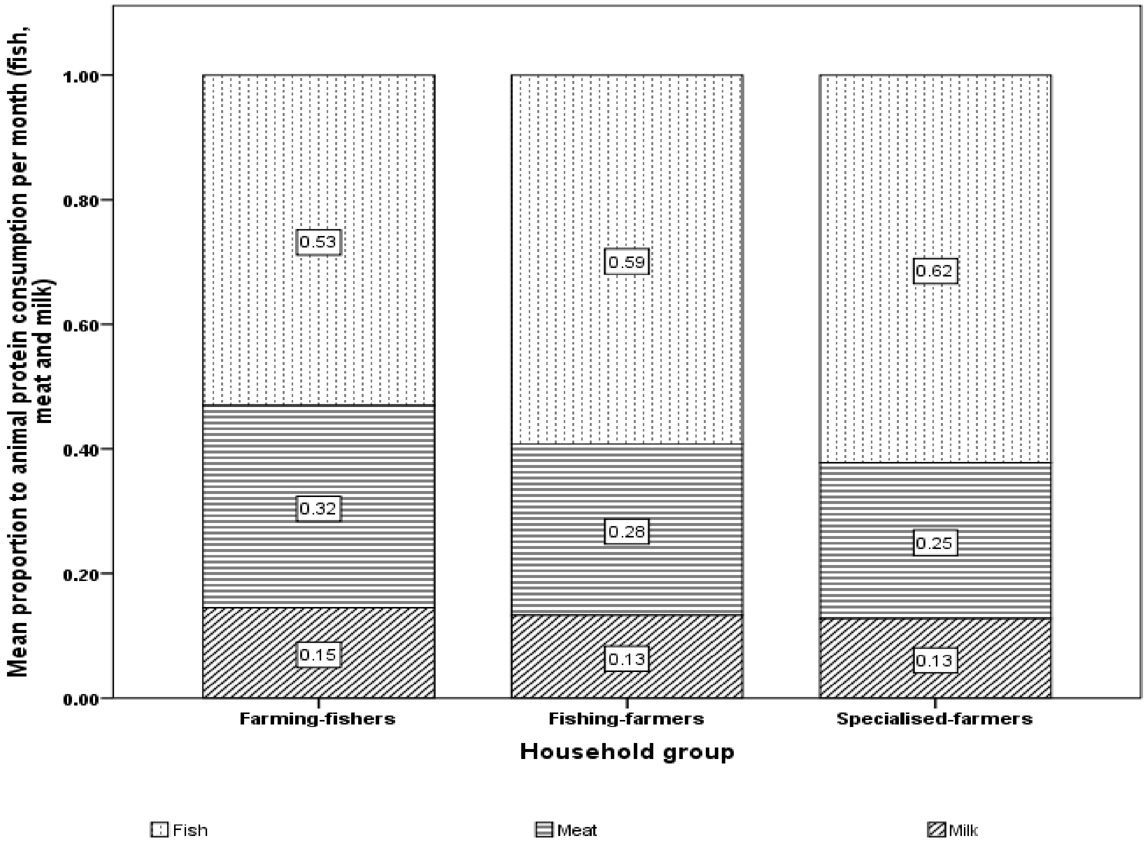

Figure 3.3: Mean proportional contribution of fish, meat and milk to animal protein consumption per month across household groups in the Lower Shire floodplain, 2008.

3.4.4 Relationship between income from fishing and expenditure of fishing households

Table 3.5: Linear relationships between income from fishing per month and expenditure of fishing households in Lower Shire floodplain, 2008.

Fishing income per month versus expenditure on:	Standardised b	R^2	p
Food (US$)	0.254	0.064	<0.001
Transport (US$)	0.129	0.017	<0.001
Medical bills (US$)	0.22	0.049	<0.001
Education (US$)	0.324	0.105	<0.001
Farm inputs (US$)	0.129	0.017	<0.05
Household amenities (US$)	0.377	0.138	<0.001
Household assets (US$)	0.449	0.202	<0.001

n = 324

Correlations between level of income from fishing and expenditure in fishing households of the Lower Shire floodplain in Table 3.5 showed that there was significant positive correlation between income from fishing and expenditure on food; expenditure on transport; expenditure on medical bills; expenditure on education; expenditure on farm inputs; expenditure on household amenities (clothes, charcoal, firewood, kerosene, soap, body lotions); and expenditure on household assets (furniture, bicycle, housing, livestock).

3.4.5 The effect of income from fishing on poverty and vulnerability

Fishing income was significant in reducing the incidence of income poverty head count among fishing households in the Lower Shire floodplain (t = 6.285, p < 0.001, n = 381; Figure 3.4). The incidence of income poverty was higher among fishing-farmers than among farming-fishers and specialised farmers without fishing income while it was higher among specialised farmers than fishing households with fishing income ($F_{without}$ = 7.024E29, p < 0.001, n = 482; F_{with} = 2.377E30, p < 0.001, n = 381, respectively; Figure 3.4).

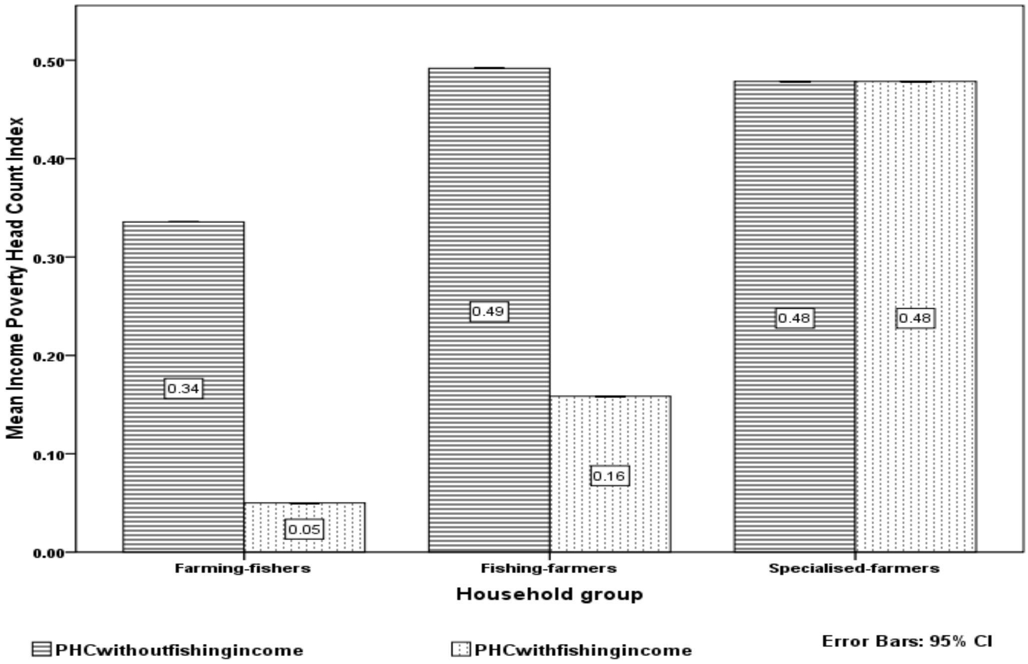

Figure 3.4: Income Poverty Head Count Index with and without fishing income in household groups of the Lower Shire floodplain, 2008.

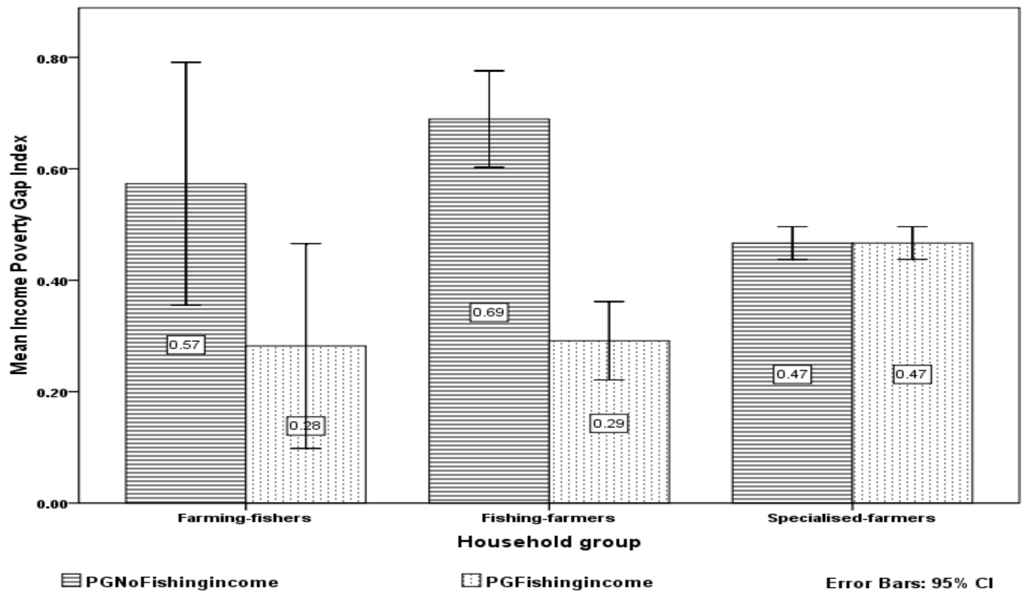

Figure 3.5: Income Poverty Gap Index with and without fishing income in household groups of the Lower Shire floodplain, 2008.

Fishing income was significant in reducing income poverty gap among fishing households in the Lower Shire floodplain (t = 5.608, $p < 0.001$, n = 381; Figure 3.5). The depth of income poverty gap was higher among fishing-farmers than among farming-fishers and specialised farmers without fishing income while it was higher among specialised farmers than fishing households with fishing income ($F_{without}$ = 4.051, $p < 0.05$, n = 482; F_{with} = 7.057, $p < 0.01$, n = 381, respectively; Figure 3.5).

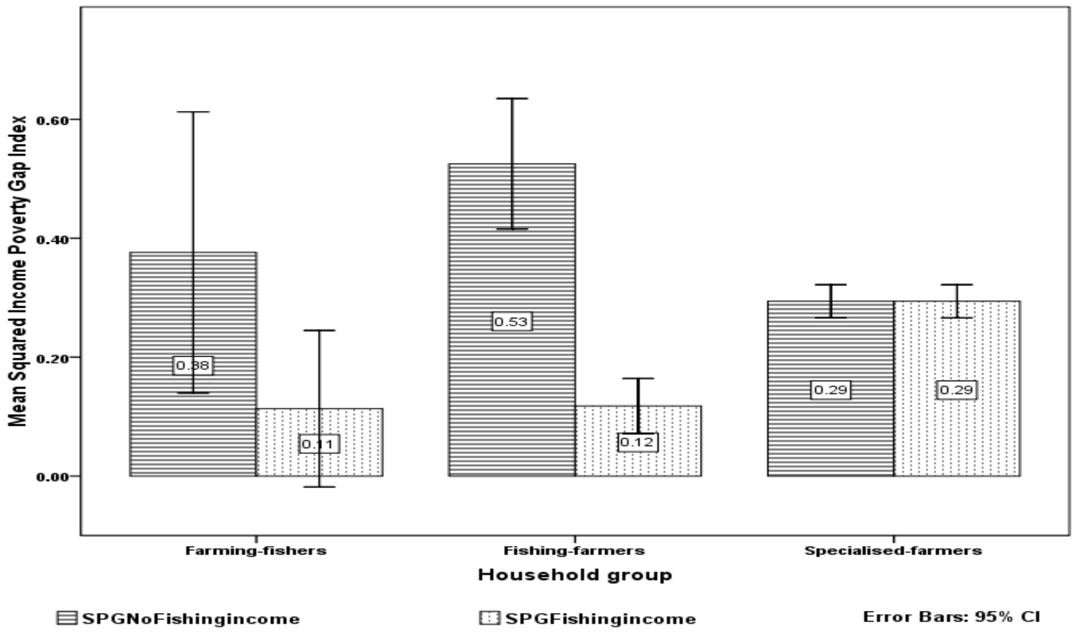

Figure 3.6: Income Squared Poverty Gap Index with and without fishing income in household groups of the Lower Shire floodplain, 2007/2008.

Fishing income was significant in reducing squared income poverty gap among fishing households in the Lower Shire floodplain (t = 5.302, p < 0.001, n = 381; Figure 3.6). The severity of squared income poverty gap was higher among fishing-farmers than among farming-fishers and specialised farmers without fishing income while it was higher among specialised farmers than fishing households with fishing income ($F_{without}$ = 4.442, p < 0.05, n = 482; F_{with} = 7.929, p < 0.001, n = 381, respectively; Figure 3.6).

Fishing income was significant in reducing economic vulnerability among fishing households in the Lower Shire floodplain (t = 10.371, p < 0.001, n = 1040; Figure 3.7). Economic vulnerability was higher in specialised farmers than fishing households both with and without fishing income ($F_{without}$ = 29.163, p < 0.001, n = 1040; F_{with} = 161.38, p < 0.001, n = 1940, respectively; Figure 3.7).

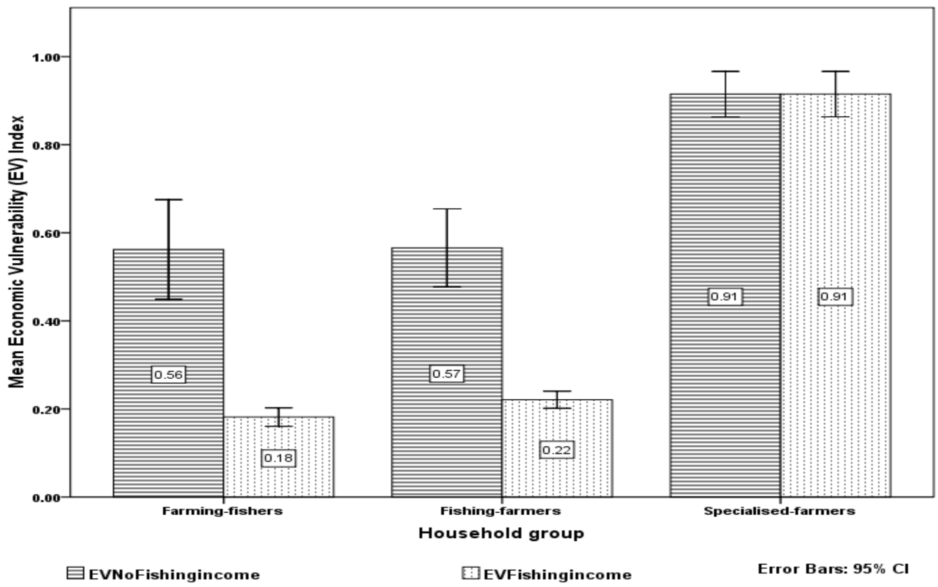

Figure 3.7: Economic Vulnerability Index with and without fishing income in household groups of the Lower Shire floodplain, 2008.

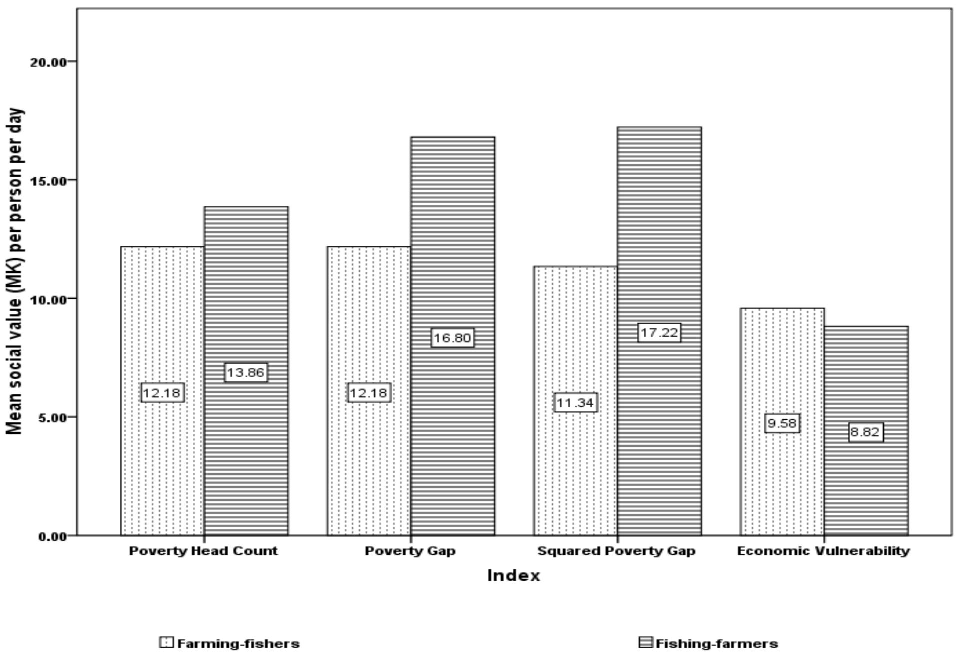

Figure 3.8: Estimates of social protection value of fishing in fishing households of the Lower Shire floodplain, 2008. (1US$ = MK141).

The effect of fishing income as a social protection mechanism per person per day in fishing households of the Lower Shire floodplain was higher for reducing depth and severity of poverty than poverty head count and income vulnerability (Figure 3.8).

3.4.6 Seasonal relationship between fishing and farming in the Lower Shire floodplain

Among fishing households of the Lower Shire floodplain, seasonal labour allocation to fishing and farming was negatively correlated (r = -1.00, n = 323, $p < 0.001$; Figure 3.9) with labour to farming being highest during October to February, a period associated with field crop production; and labour to fishing peaking during May to September, a period associated with receding floods and low labour demand for farming.

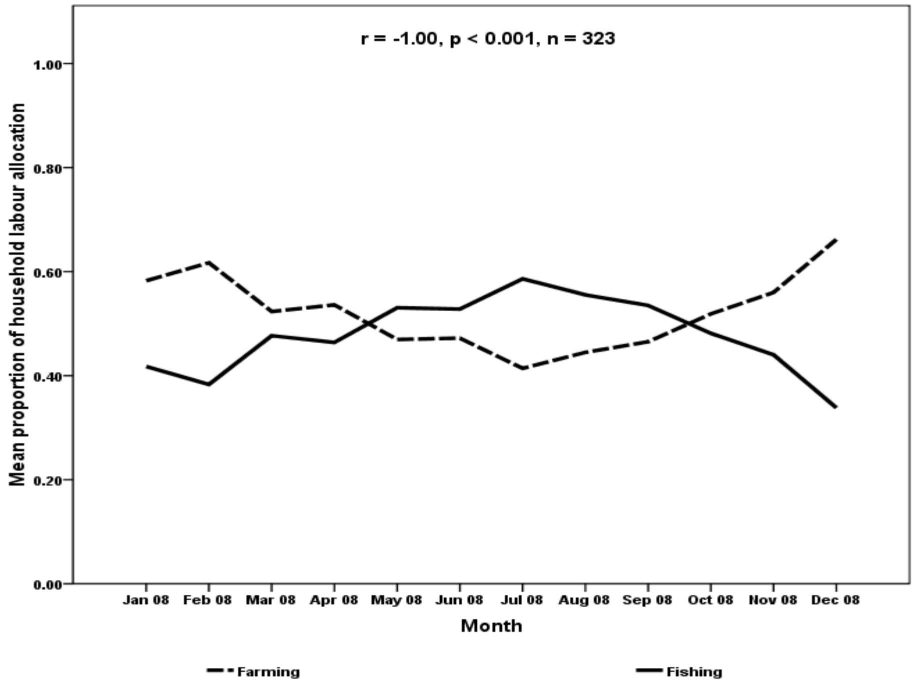

Figure 3.9: Relationship between seasonal household labour allocation to fishing and farming in fishing households of the Lower Shire floodplain, 2008.

In fishing households of the Lower Shire floodplain, contribution of fishing to household income per month was negatively correlated with contribution of farming to household income per month (r = -0.709, n = 323, $p < 0.001$; Figure 3.10).

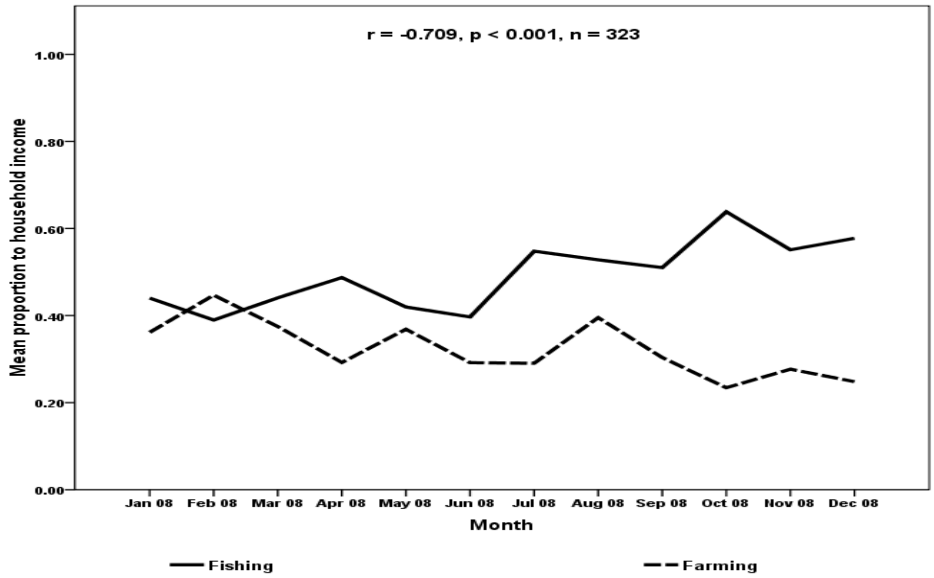

Figure 3.10: Relationship between seasonal proportion of household income from fishing and farming in fishing households of the Lower Shire floodplain, 2008.

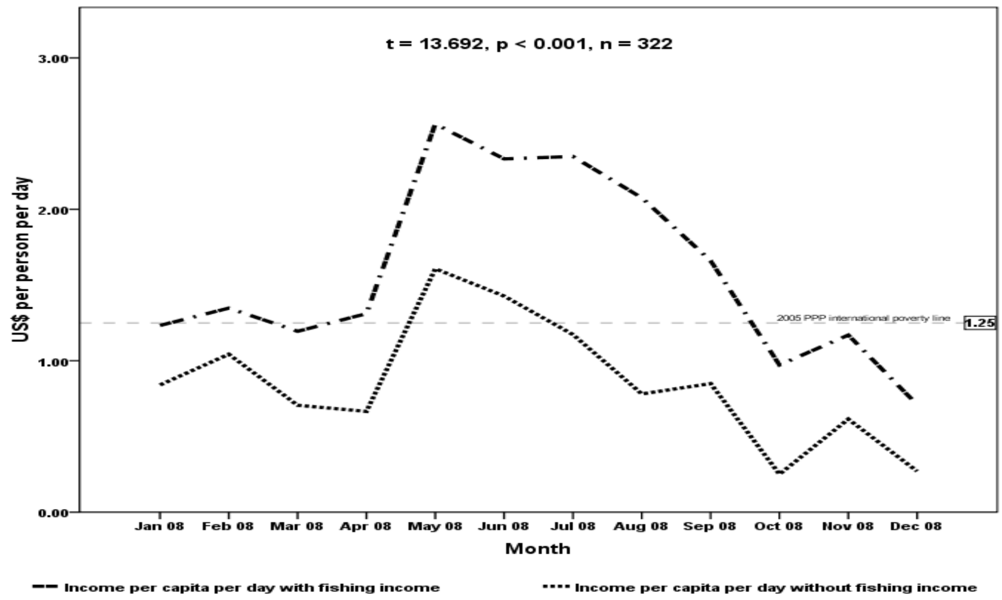

Figure 3.11: Relationship between seasonal fishing income and income poverty in fishing households of the Lower Shire floodplain, 2008.

In the Lower Shire floodplain, number of fishing households below the international PPP poverty line of US$ 1.25 per person per day was lower with fishing income than without fishing income in each month (t = 13.692, n = 322, p < 0.001; Figure 3.11). The per capita income per person per day with fishing income was above the US$ 1.25 per person per day between April and September (Figure 3.11), a period associated with higher labour allocation to fishing (Figure 3.9), receding floods and higher fishing income.

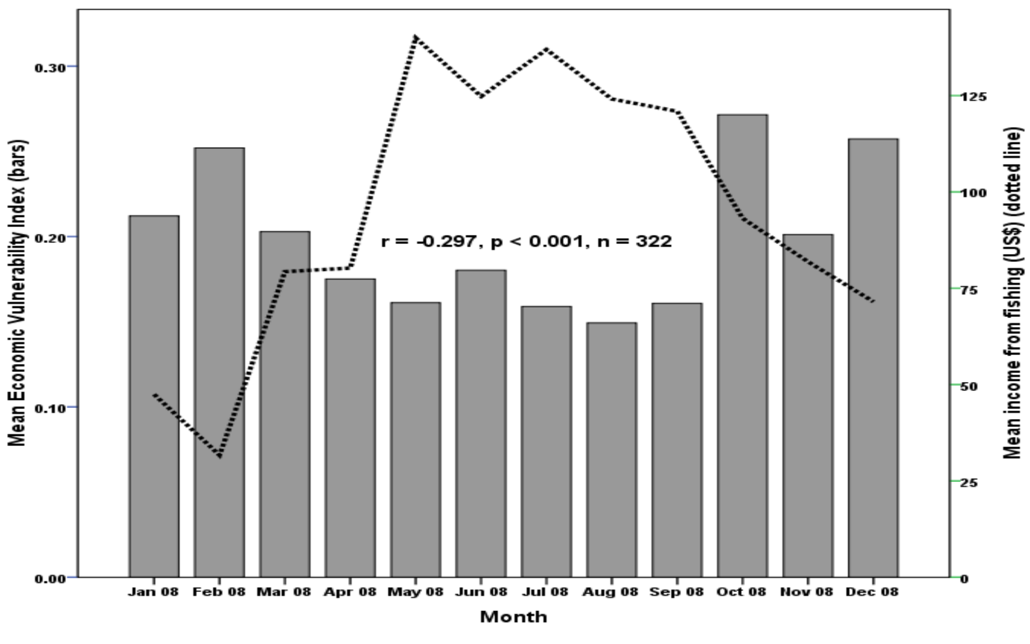

Figure 3.12: Relationship between seasonal fishing income and economic vulnerability in fishing households of the Lower Shire floodplain, 2008.

Among fishing households in the Lower Shire floodplain, the period of higher fishing income was associated with lower economic vulnerability (April-September) and vice versa (r = -0.297, n = 323, $p < 0.001$; Figure 3.12).

Expenditure on farm inputs among fishing households in the Lower Shire floodplain was positively correlated with fishing income per month (r = 0.129, n = 322, $p < 0.05$; Figure 3.13) and was higher during the period of higher income from fishing.

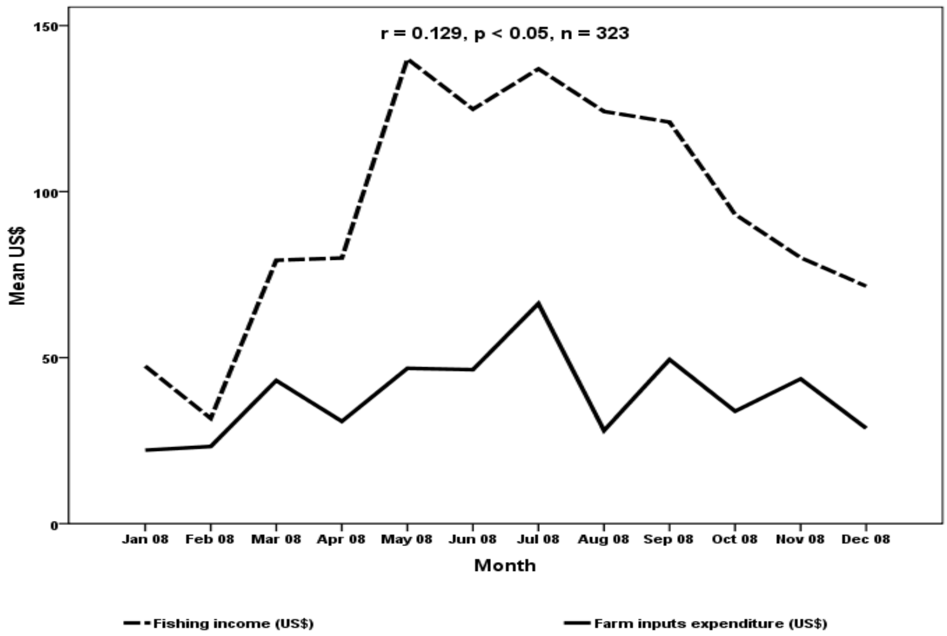

Figure 3.13: Relationship between seasonal fishing income and expenditure on farm inputs in fishing households of the Lower Shire floodplain, 2008.

3.4.7 The inter-annual trends in local rainfall, fisheries and agricultural production

Annual local rainfall in the Lower Shire floodplain was below average between 1989 and 1994 and also between 2001 and 2004 whereas it was above average for the period between 1995 and 2000 (Figure 3.14). In particular, local rainfall was lower than average by 56 per cent in 1991 and by 38 per cent in 2004 suggesting that the 1991/2 and 2004/5 seasons had severe droughts. The long-term trend in annual local rainfall variability between 1986 and 2005 was insignificant ($t = 0.014$, $p > 0.05$, n = 19; Figure 3.14).

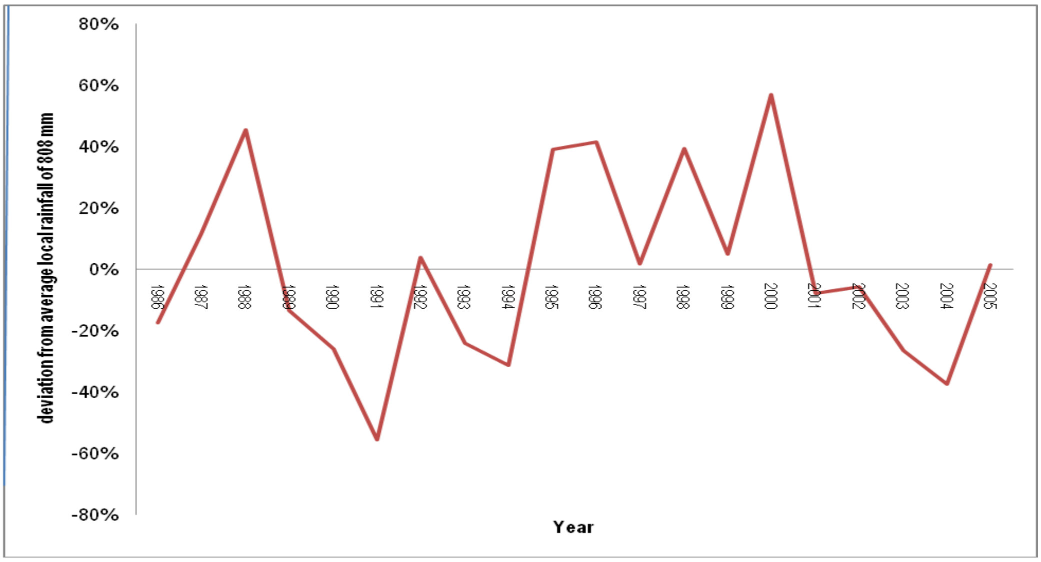

Figure 3.14: Inter-annual local rainfall variability in the Lower Shire floodplain, 1986-2005.

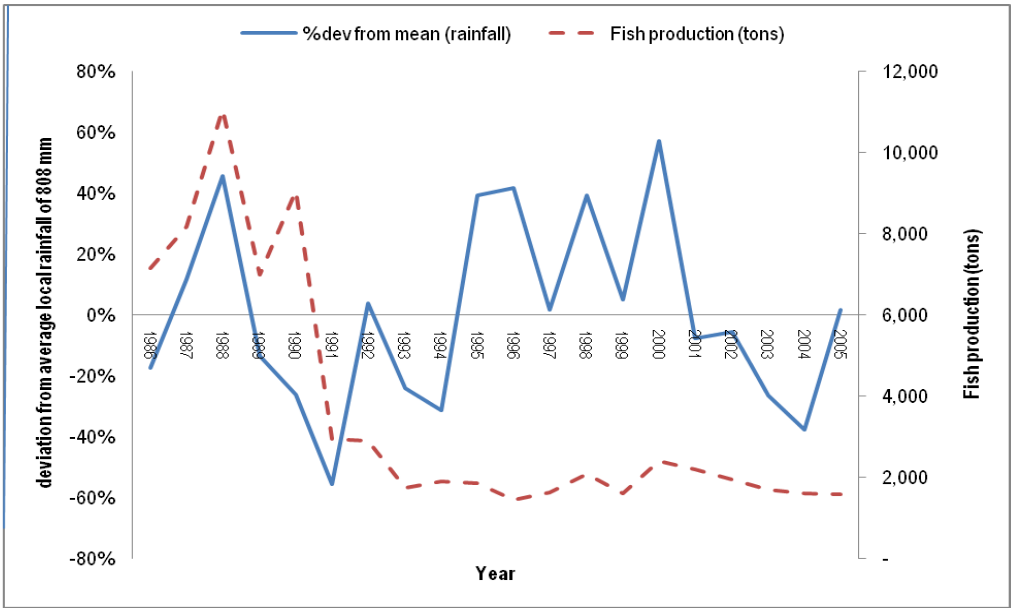

Figure 3.15: The inter-annual relationship between local rainfall variability and fish production in the Lower Shire floodplain, 1986-2005.

The long-term trend in annual fish production was significant between 1986 and 2005 (t = 2.37, $p < 0.05$, n = 19; Figure 3.15) and has maintained a downward trend since 1990. Annual fish production in the Lower Shire floodplain had insignificant positive correlation with annual local rainfall variability between 1986 and 2005 (r = 0.07, n = 20, $p > 0.05$; Figure 3.15) suggesting that fish production had a weak relationship with local rainfall variability. The downward trend in fish production continued even during years of above average local rainfall (between 1995 and 2000; Figure 3.15).

The long-term trend in annual maize production in the Lower Shire floodplain was insignificant between 1986 and 2005 (t = 1.429, p > 0.05, n = 19; Figure 3.16). Annual maize production was positively correlated with annual local rainfall variability between 1986 and 2005 (r = 0.38, n = 20, p < 0.05; Figure 3.16) implying that maize production had a strong relationship with local rainfall variability in Lower Shire floodplain with years of below average local rainfall associated with low maize production and years of above average local rainfall associated with high maize production. Maize yield also followed the same pattern (Figure 3.17).

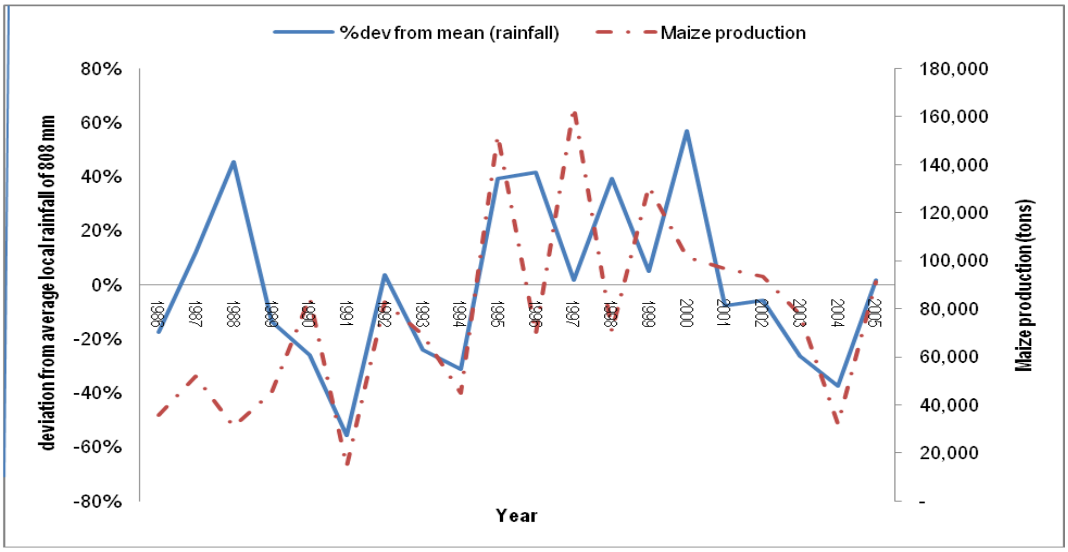

Figure 3.16: The inter-annual relationship between local rainfall variability and maize production in the Lower Shire floodplain, 1986-2005.

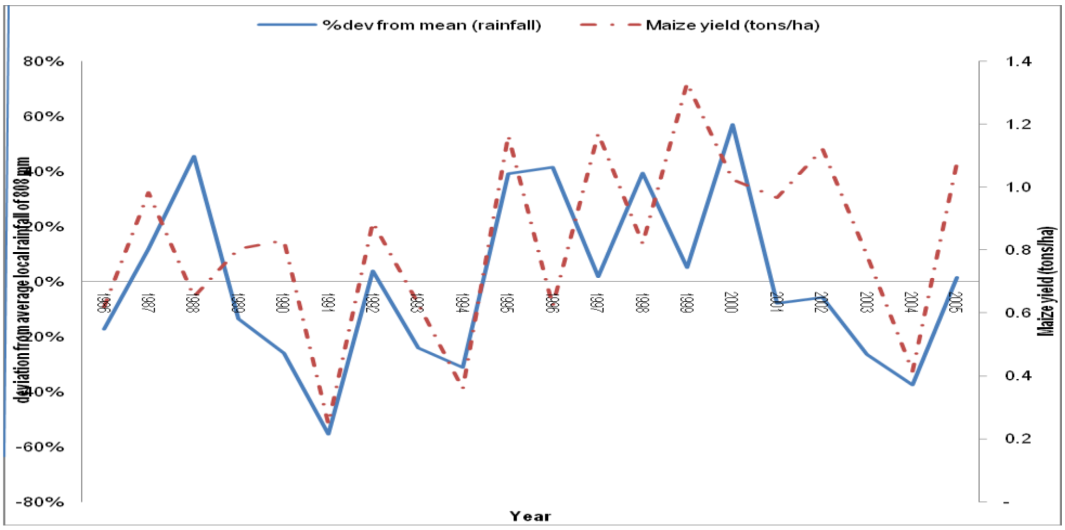

Figure 3.17: The inter-annual relationship between annual local rainfall variability and maize yield in Lower Shire Valley, 1986-2005.

Figure 3.18 shows that annual fish production had a negative relationship with changes in annual maize production between 1986 and 2005 (r = -0.426, $p < 0.05$, n = 20). The relationship showed that years of low maize production were associated with falling fish production and years of high maize production were associated with rising fish production (Figure 3.18).

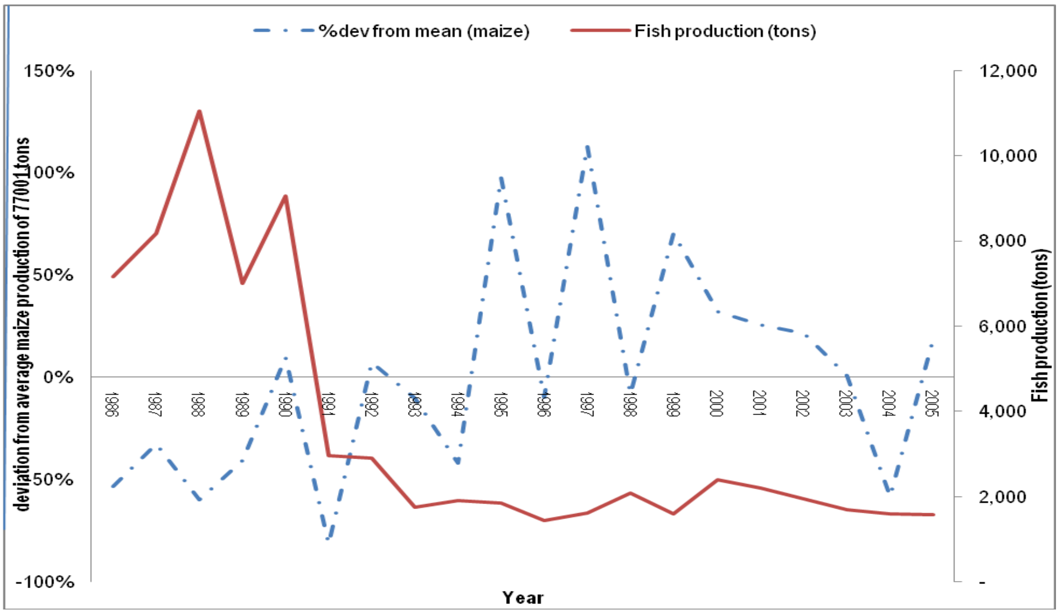

Figure 3.18:Inter-annual relationship between changes in maize production and fish production in Lower Shire floodplain, 1986-2005

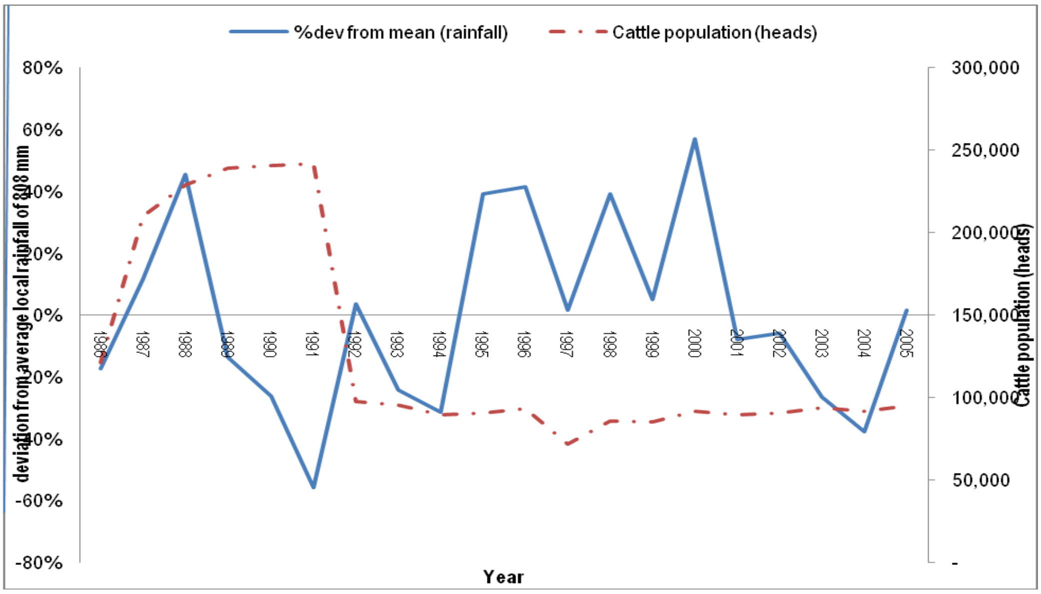

Figure 3.19: The inter-annual relationship between local rainfall variability and cattle population in Lower Shire floodplain, 1986-2005

The long-term trend in the population of cattle in the Lower Shire floodplain was insignificant from 1986 to 2005 (t = 1.429, $p > 0.05$, n = 19; Figure 3.19) but had a huge drop between 1992 and 1993 and had maintained low numbers since then.

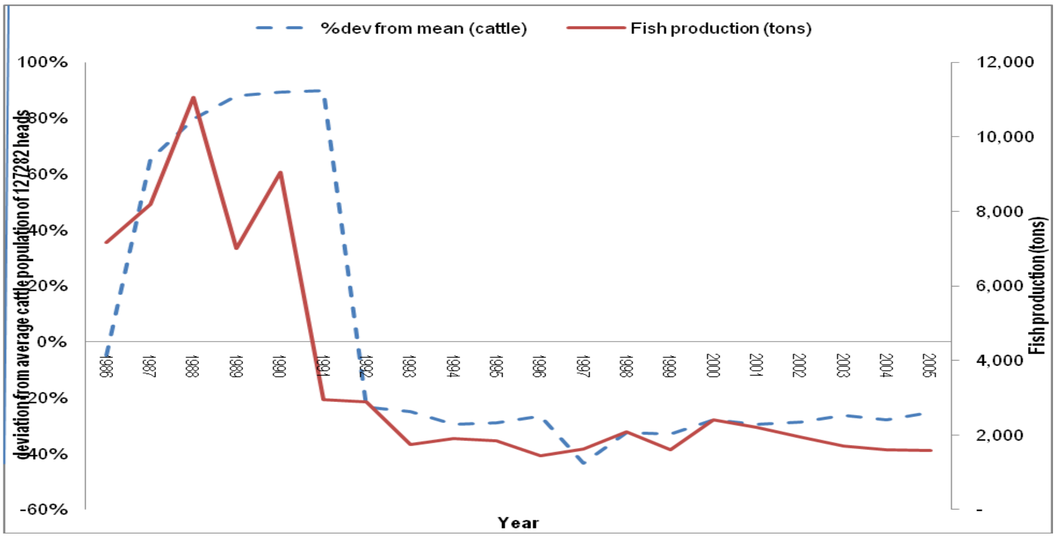

Figure 3.20: The inter-annual relationship between changes in cattle population and fish production in Lower Shire floodplain, 1986-2005.

Figure 3.20 shows that annual fish production had a positive relationship with changes in annual cattle population between 1986 and 2005 (r = 081, $p < 0.05$, n = 20). The relationship showed that years of high fish production were associated with high cattle population and years of low fish production were associated with low cattle population (Figure 3.20).

The long-term trend in per capita annual fish production and cattle population had significant downward pattern in the Lower Shire floodplain between 1986 and 2005 (t_{fish} = 2.847, $p <$ 0.05; t_{cattle} = 4.79, $p < 0.001$, n = 19, Figure 3.21) while the per capita annual maize production had a rising trend between 1986 and 1997 and a declining trend between 1997 and 2005 (t_{maize} = 3.051, $p < 0.01$, Figure 3.20). Between 1986 and 2005, per capita fish production and cattle population had negative correlation with human population (r = -0.567 for fish production and r = -0.553 for cattle population, p < 0.05, n = 20) suggesting that population growth in Lower Shire floodplain was higher than the growth in fish and cattle production while maize production had insignificant positive correlation with human population growth (r = 0.01, p > 0.05, n = 20; Figure 3.21).

The per capita fish production has declined by about 88 per cent from around 20 kg per person per year in the 1980s to around 2.5 kg per person per year in 2000s while per capita maize production varied with local rainfall variability with years of below average rainfall associated with low per capita maize production and per capita cattle heads has declined by about 60 per cent from around 0.5 heads per person per year in the 1980s to around 0.2 heads per person per year in the 2000s (Figure 3.21).

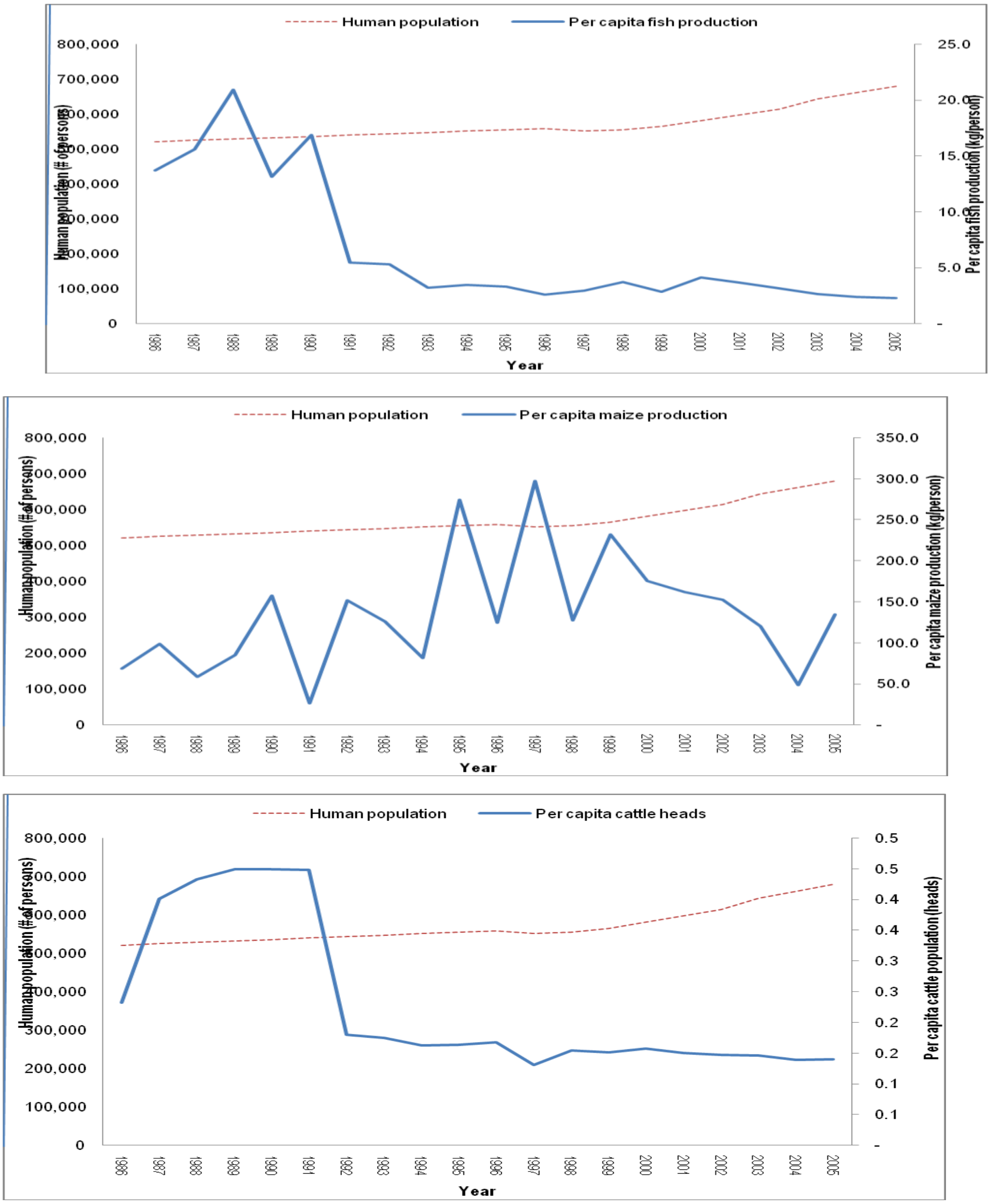

Figure 3.21: The inter-annual relationship between population growth and per capita fish (above), maize (middle) and cattle population (below) in Lower Shire floodplain, 1986-2005.

3.5 DISCUSSION

3.5.1 Socio-economic characteristics of households and fishing occupation

In the Lower Shire floodplain, fishing was mostly undertaken by households that also engaged in other activities especially farming (Table 3.1). JICA and GoM (2005) also reported a decline in number of fishing households between 1976 and 2000 in the Lower Shire floodplain which others have attributed to the declining fish production (Turpie *et al*. 1999, Kansau and Chimatiro 1997; Figure 3.15). The results also showed that fishing in the Lower Shire floodplain was mainly undertaken by households that had smaller land holding sizes, more labour from male members and higher income from off-farm activities (Table 3.1) and level of time spent fishing increased with larger household sizes, more labour from male members and higher income from off-farm activities (Table 3.42). The findings supported earlier observation by Turpie *et al*. (1999) which indicated that the fisheries resources in the Lower Shire floodplain were largely exploited by households with a mixed livelihood strategy. This type of natural resource harvesting has also been reported in Namibia in Chobe-Caprivi Wetlands as a risk spreading mechanism to even out household income and food consumption (LaFranchi 1996). Turpie (2003) also noted that rural households would rather diversify activities as a means of risk spreading instead of maximising income through specialisation. The current findings in the Lower Shire floodplain also showed that fishing households had higher household income per month than specialised farmers (Table 3.1) providing evidence that households with a mixed strategy of fishing maximised household income.

The findings also suggested that fishing in the Lower Shire floodplain was dominated by male members and households that have less land but with significant income from off-farm activities. Given that most fishing households were headed by younger and educated heads (Table 3.1), the results implied that fishing was indeed undertaken as part of livelihood diversification strategy. Empirical evidence in Malawi also shows that higher level of education of household head is associated with diversified livelihood strategies among small-holder farmers as a risk spreading mechanism (FFSSA 2004, GoM 1999). Studies by Baldacci *et al.* (2008), Ravallion and Chen (1997) also showed that level of education had significant influence on livelihood choices especially in low income countries and in particular, the sub-Saharan Africa. Findings in North East Nigeria by Neiland *et al.* (1997), in Lake Chad by Sarch (1997) and in Lake Victoria by Geheb and Binns (1997) also indicated that fishing was undertaken as part of a mixed livelihood strategy by farming households.

3.5.2 The role of fishing as a source of income and animal protein

Although most households were not engaged in fishing as compared to farming in the Lower Shire floodplain, fishing provided the highest contribution to total household income among fishing households and to animal protein consumption even among specialised-farming households compared to other sources (Figures 3.2 and 3.3, respectively). The importance of fishing as the main source of income among fishing households has also been reported in lakes and marine fisheries (Guillemot 2009, Cinner *et al*. 2008, Jul-Larsen *et al*. 2003, Allison and Mvula 2002, Njaya 2002). The contribution of fishing to animal protein consumption was higher in specialised farmers than in fishing households. Whereas fishing contributed about 53 per cent to animal protein consumption in farming-fishers, it contributed about 59 per cent in fishing-farmers and about 62 per cent in specialised farmers (Figures 3.3) while the inverse was observed for its contribution to household income (Figure 3.2).

The findings implied that fishing objectives varied within fishing households in the Lower Shire floodplain to the extent that households that spent more time in fishing maximised household income from fishing while those that spent less time in fishing maximised animal protein consumption from fishing. The higher contribution of fishing to animal protein consumption among specialised farmers also indicated that fishing was the most affordable source of animal protein compared to meat and milk in the floodplain. Similar conclusions have also been reached by JICA and GoM (2005) and WFC (2005) which singled out fishing as an important source of cheap protein to mitigate the impact of HIV/AIDS in Malawi and in tropical Africa, respectively.

Income from fishing had significant contribution to expenditure on food, transport, education, medical bills, farm inputs, household amenities and assets among fishing households in the Lower Shire floodplain (Table 3.5). The findings suggested that although fishing households in the Lower Shire floodplain had less land holding sizes, income from fishing supported food and farm inputs expenditures thereby contributing to household food security. The capacity to attain food security through the market in Malawi is strongly correlated to the level of income, availability of the food and access to the food (GoM 2006, NSO Malawi 2005). In addition, income from fishing also supported expenditures on social service (education, medical, transport) and this was also reflected by higher education level among fishing households compared to specialised farmers (Table 3.1). Investment in human capital has been found to have a direct impact on the range of livelihood choices that a household can choose from to safeguard against future vulnerability and poverty (DFID 1999).

3.5.3 The role of fishing in reducing income poverty

The findings in the Lower Shire floodplain showed that income from fishing significantly reduced the incidence of income poverty, poverty gap and squared poverty gap among fishing households leading to low income poverty rates in fishing households than among specialised farmers (Figures 3.4 to 3.6). The incidence of poverty in both farming-fishers and fishing-farmers was lower with fishing income than the recently estimated 40 per cent rural poverty rate in Malawi (GoM 2008) while that of specialised farmers was higher than the rural poverty rate. The results suggested that fishing households in the Lower Shire floodplain were relatively better-off than specialised farmers. As observed earlier on, fishing households obtained the highest income from fishing than any other source of income (Figure 3.2) implying that fishing was effectively contributing to low poverty rates among fishing households in the Lower Shire floodplain. Allison and Mvula (2002) also showed similar relationship between fishing and poverty in fishing communities of Lake Malawi.

Although fishing households had less land holding sizes than specialised farmers, they had at least an average of 1 ha of land (Table 3.1). Chirwa (2008) showed that such land holding size was significant enough to ensure household food security in rural Malawi. FFSSA (2004) also made similar conclusion among smallholder farmers in agriculture in Southern Africa. Fishing played a risk spreading role in the Lower Shire floodplain which smoothes household income consequently leading to higher welfare among fishing households than in specialised farming households (Table 1.1). The results demonstrated that choice of management objectives of the Lower Shire floodplain fisheries (Figure 1.2) should take into account the role played by the fisheries in poverty reduction among fishing households of the floodplain.

3.5.4 The role of fishing in reducing economic vulnerability

Economic vulnerability in fishing households of the Lower Shire floodplain was lower than in specialised farming households both with and without fishing income (Figure 3.7) suggesting that specialised-farming households were both income poorer and more income vulnerable than fishing households. The findings highlighted the advantages of fishing over other sources of income such as farming in the sense that fishing provides a regular source of cash to fishing households which ensures higher household income security and low economic vulnerability. Such observations have also been reported in Salonga in Congo DRC where fishing was reported to function as the bank in the water through its regular cash in-flows to the fishing households (Béné *et al*. 2009). Fishing was therefore a crucial element of risk spreading in terms of household income among households in the Lower Shire floodplain. The findings were also consistent with other studies on poverty and vulnerability (FAO 2005, Ellis 2000, DFID 1999) and conformed to earlier suggestion by Baulch and Hoddinott (2000) that the poverty problem may be as a result of a higher turnover of vulnerable households especially among specialised farming households.

However, the findings were contrary to emerging thinking among fisheries economists which suggests that fishing households may not necessarily be worse-off in the sense of income poverty but may suffer from higher vulnerability that render them more prone to poverty (Béné 2009, Allison and Horemans 2006, Allison *et al*. 2006, Béné *et al*. 2003). Based on the formula for economic vulnerability used in this study and the definition of economic vulnerability derived from that formula, the findings in the Lower Shire floodplain show that fishing households were both income better-off and less income vulnerable than specialised farming households.

3.5.5 The role of fishing as a social protection mechanism

The value of fishing as a social protection mechanism in the Lower Shire floodplain was estimated at about US$ 0.30 per person per day in terms of poverty reduction and at about US$ 0.07 per person per day in terms of economic vulnerability reduction (Figure 3.8). The social value of fishing in terms of poverty reduction was equivalent to about 52 per cent of the government stipulated daily minimum wage for agricultural labourers in Malawi (GoM 1999). The Lower Shire floodplain fishery was therefore critical in cushioning fishing households from falling below the minimum income levels that could have resulted into higher poverty and vulnerability rates. In this way, the Lower Shire floodplain fishery performs a social assistance function in fishing households (Table 1.1; ODI 2001) which would have otherwise required public or private support.

3.5.6 Seasonality of fishing and farming in the Lower Shire floodplain

A number of studies indicate that where fishing is highly seasonal, like in floodplains, households usually combine fishing with other activities especially farming and livestock rearing (Islam and Braden 2006, Neiland *et al*. 1997, Sarch 1997, Geheb and Binns 1997).

Most of the households in the floodplain communities opportunistically harvest the fish while also engaging in other activities (Haller 2003, Turpie *et al.* 1999) as part of a livelihood system. The level of importance of each activity within the livelihood system has immediate implications on how households make decisions on resource allocation such as labour. In rural economies, like the case in Lake Chad, the link and complementarily of the livelihood strategies within the livelihood system have been found to influence household decisions on resource allocation (Sarch 1997).

The results in the Lower Shire floodplain also showed that fishing was seasonally and negatively correlated with farming in terms of household labour allocation and contribution to household income (Figures 3.9 and 3.10). Household labour allocation to fishing was particularly higher between May and September (Figure 3.9), the period associated with low field crop activities. The findings also corroborated those by Kalowekamo (2000), Turpie *et al*. (1999), Chimatiro and Mwale (1998) and Kansau and Chimatiro (1997). Consequently, the proportion of income from fishing to household income also followed the same seasonal pattern (Figure 3.10).

Chimatiro (2004) also reported that fish catches were relatively higher during the receding period of floods which usually begins around March and April. The results also showed that fishing income per month also started rising from almost the same period and had significant effect in reducing income poverty (Figure 3.11) and economic vulnerability (Figure 3.12). Additionally, the period of higher fishing income was also associated with higher expenditure on farm inputs (Figure 3.13).

The findings demonstrated that fishing and farming were seasonally complementary in fishing households in the Lower Shire floodplain and seasonal fishing income played an important role in alleviating income poverty and economic vulnerability as well as supporting purchase of farm inputs. Turpie (2003) also noted that in the Zambezi Basin wetlands, livelihood strategies adopted by rural households tended to be complementary to each other in terms of income. Without fishing income, the proportion of households below the 2005 PPP poverty line of US$ 1.25 per person per day was higher among fishing households in the Lower Shire floodplain and it was only above the poverty line in May and June (Figure 3.11), the months that are associated with more cash income from farming, whereas with fishing income, poverty rate was very low, only recording below poverty line in months associated with low income from fishing (October-December). The current findings suggested that fishing has a strong seasonal effect on the income of fishing households in the Lower Shire floodplain and effectively serves as a risk spreading strategy to income poverty and economic vulnerability reduction.

3.5.7 Relationship between inter-annual rainfall, fisheries and agricultural production

Unlike maize production, fish production and cattle population have declined in the Lower Shire floodplain over the last two decades despite periods of above or below average rainfall (Figures 3.15, 3.16 and 3.19). The decline in fish production was directly attributed to increase in fishing effort (Bulirani *et al*. 1999, DoF Malawi 2000) due to weak institutional support to enforce fisheries regulation and lack of co-management initiatives but also droughts that prevailed between 1990 and 1992 (Chimatiro 2004). The droughts of 1991/1992 and 2003/2004 were among the major droughts experienced in Malawi that disrupted a number of livelihoods including agriculture (FAO and WFP 2005). As can be observed in Figure 3.19, even cattle population also drastically declined after the drought of 1991/1992 season due to increase of disease outbreaks, among other factors. A study by Ellis *et al*. (2003) also found that the decline in cattle heads in Malawi after the 1991/2 drought was also largely caused not by the drought itself but by the breakdown in internal security due to the political regime change around that time and the rapid increase in livestock theft driven by raids from neighbouring Mozambique.

Nevertheless, while maize production was positively correlated with local rainfall, fish production and cattle population did not directly correlate with local rainfall and showed high decline after the 1991/2 drought albeit other factors. The effects of droughts on fish production exposed the extent of susceptibility of the Lower Shire floodplain fishery to rainfall variability which has also been observed in other water bodies (Jul-Larsen *et al.* 2003, Njaya 2002, Kolding 1994, Laë 1994, Lowe-McConnell 1979, Welcomme 1974). The continued decline in fish production long after the droughts had occurred is a clear indication that the Lower Shire floodplain is not only affected by rainfall variability but also other institutional and human factors. These could include poor enforcement of regulations due to inadequate human capacity leading to high fishing effort, use of inappropriate fishing gears and methods.

Since fishing in the Lower Shire floodplain has been found to be significant in reducing income poverty and economic vulnerability (Figure 3.11 and 3.12), the current trend in fish production (Figure 3.15) poses a huge threat to the livelihoods of the fishing communities. Ellis (2001) observed that the most robust livelihood system is one displaying high resilience and low sensitivity; while the most vulnerable displays low resilience and high sensitivity (where resilience is understood as the ability of an ecological or livelihood system to bounce back from stress or shocks while sensitivity means the magnitude of a system's response to an external disturbance). If the status quo in terms of fisheries management remained, the contribution of the Lower Shire floodplain fisheries to welfare and social protection value would dissipate with the increasing variability in local rainfall patterns as a result of El Niño/La Niña conditions and episodes (NCDC 2009).

3.6 SUMMARY

The analysis in the Lower Shire floodplain has shown that fishing households tended to be young and highly educated with larger household sizes but smaller land holding sizes than specialised farming households. Fishing was the major source of income among fishing households and the major source of animal protein in both fishing and specialised farming households. Household income was higher in fishing households than specialised farming households and income from fishing tended to be positively correlated with expenditure on farm inputs and social services such as education, medical and transport.

The analysis also indicated that income from fishing in the Lower Shire floodplain had significant impact on reducing income poverty and economic vulnerability to the extent that poverty and vulnerability rates were higher in specialised farming households than in fishing households. As a result, fishing played an equally important role in social protection by cushioning fishing households from experiencing lower levels of income and animal protein consumption. In essence, fishing performed a risk spreading role in the Lower Shire floodplain essential for smoothing income and food consumption.

The study also demonstrated that fishing and farming in the Lower Shire floodplain were seasonally complementary both in terms of household labour usage and income and seasonal fishing income had significant impact in reducing income poverty and economic vulnerability. Fishing was therefore an effective diversification strategy among households in the Lower Shire floodplain. However, the future of these welfare and social protection functions performed by the fisheries in the Lower Shire floodplain are in a state of quagmire. Fish production has maintained a declining trend since the drought of 1991/1992 despite seasons of above average rainfall between 1995 and 2000 unlike maize production. Certainly, business as usual is not an option as far as management of the Lower Shire floodplain fishery is concerned, not only for the purpose of securing the welfare and social protection functions to fishing households but also due to increasing menace of local rainfall variability and rising poverty levels in the rural areas in Malawi.

CHAPTER FOUR: COMPARISON OF THE KAFUE AND THE LOWER SHIRE FLOODPLAIN COMMUNITIES

4.1 INTRODUCTION

Natural resources sustain the livelihoods of rural communities in developing countries through their contribution to household income, food and employment (WFC 2008, Baran *et al*. 2007, Bennett and Thorpe 2003, Chong *et al*. 2003, Neiland and Béné 2003, Turpie 2003, Chapters 2 and 3 of this study). In particular, river and floodplain fisheries have been reported to support many households in major river basins like Amazon, Congo, Ganges, Mekong, Niger, Zambezi and others (Neiland and Béné 2003). For instance, studies in the Zambezi River Basin have shown that natural resources harvested from the wetlands, particularly fish, directly benefit households in the Kafue floodplain in Zambia (WWF 2004, Chapter 2 of this study) and households in the Lower Shire floodplain in Malawi (Turpie *et al.* 1999, Chapter 3 of this study). Besides direct income, food and employment; inland small-scale fisheries may also have indirect multiplier effects impacting on the rural communities (Béné 2006).

Béné (2006) also highlighted the importance of small-scale inland fisheries in supplementing the income and food security of poor rural households with limited or no access to land and other factors of production. In some areas, inland small-scale fisheries may be the only natural resource asset which is accessible by poor and vulnerable households as a safety net against exogenous stresses and shocks and as a means of reducing inequalities among rural communities. The analysis in this chapter is founded on the premise that there are significant differences in the characteristics of the communities found in the Kafue floodplain and those found in the Lower Shire floodplain which affect their degree of fishing. The objectives of this chapter are therefore:

1. To compare the socioeconomic characteristics of households in the two floodplain communities.
2. To evaluate the livelihood strategies of households in the two floodplain areas and compare the role played by fishing.
3. To compare the effect of land holding, cattle ownership and alternative income sources on time spent fishing in the two floodplain areas.

4. To assess the levels of poverty and vulnerability in the two floodplain communities and compare the welfare value of fishing.

4.2 RESULTS

4.2.1 Demographic characteristics of households

There was no difference in the number of persons per household in both floodplains but households in the Kafue floodplain spent more time per month in fishing while households in the Lower Shire floodplain spent more time per month in farming (p < 0.001; Table 4.1). Heads of households in the Kafue floodplain were relatively older; less educated and had shorter residence in the floodplain than those in the Lower Shire floodplain (p < 0.05, p < 0.001; Table 4.1).

Table 4.1: Characteristics of households in the Kafue and the Lower Shire floodplains, 2007/2008

	Kafue floodplain	**Lower Shire floodplain**	**t-test**
Mean	n = 891	n = 1044	
Household size (# of persons)	5.31 (0.087)	5.12 (0.067)	1.664
Farming time per month (hours)	132.24 (4.64)	194.4 (4.15)	-9.972***
Fishing time per month (hours)	275.21 (6.94)	34.0 (1.92)	33.473***
Age of household head (years)	41.98 (0.416)	40.64 (0.372)	2.406*
Period of residence (years)	18.54 (0.493)	26.99 (0.508)	-11.947***
Formal education (years)	2.27 (0.114)	3.96 (0.109)	-10.696***

Figures in brackets are standard errors. = significant at p < 0.05, *** = significant at p < 0.001.*

4.2.2 Livelihood assets of households

Households in the Kafue floodplain had smaller land holding sizes, more cattle and higher fish catch per month than households in the Lower Shire floodplain (p < 0.001; Table 4.2).

Table 4.2: Livelihood assets of households in the Kafue and the Lower Shire floodplains, 2007/2008

	Kafue floodplain	**Lower Shire floodplain**	**t-test**
Mean	n = 891	n = 1044	
Land holding size (ha)	0.73 (0.026)	1.15 (0.019)	-12.935***
Cereal grain harvested (kg)	416.95 (20.97)	716.63 (20.37)	-11.79***
Cattle (heads)	2.59 (0.188)	0.52 (0.056)	10.528***
Fish catch per month (kg)	86.21 (4.022)	11.97 (1.043)	17.866***

*Figures in brackets are standard errors. *** = significant at p < 0.001.*

4.2.3 Sources of household income

Households in the Kafue floodplain had higher income per month than those in the Lower Shire floodplain ($p < 0.01$; Table 4.3). Fishing was the major source of household income in the Kafue floodplain followed by livestock, farming and off-farm activities while farming was the major source of household income in the Lower Shire floodplain followed by off-farm activities, fishing and livestock ($p < 0.001$; Table 4.3).

Table 4.3: Main sources of household income in the Kafue and the Lower Shire floodplains, 2007/2008

Mean	Kafue floodplain n = 891	Lower Shire floodplain n = 1044	t-test
Household income per month (US$)	152.49 (8.547)	120.41 (5.33)	3.184**
Proportion fishing income	0.497 (0.014)	0.152 (0.008)	20.851***
Proportion farming income	0.103 (0.008)	0.471 (0.012)	-26.118***
Proportion of livestock income	0.262 (0.011)	0.10 (0.007)	12.159***
Proportion of off-farm income	0.105 (0.007)	0.272 (0.011)	-12.884***

*Figures in brackets are standard errors. ** = significant at p < 0.01, *** = significant at p < 0.001.*

4.2.4 Sources of animal protein

Animal protein consumption (meat, fish and milk) was higher in the Kafue floodplain than in the Lower Shire floodplain ($p < 0.001$; Table 4.4) but fish contributed more than half of animal protein consumed per month in both floodplains ($p < 0.001$; Table 4.4). The contribution of fish and meat to animal protein consumption was lower in the Kafue floodplain than in the Lower Shire floodplain while that of milk was higher in the Kafue than in the Lower Shire floodplain ($p < 0.05$, $p < 0.001$, respectively; Table 4.4).

Table 4.4: Consumption of meat, fish and milk in households of the Kafue and the Lower Shire floodplains, 2007/2008

Mean	Kafue floodplain n = 891	Lower Shire floodplain n = 1044	t-test
Protein consumed per month (kg)	8.28 (0.164)	6.99 (0.147)	5.816***
Proportion fish	0.561 (0.009)	0.604 (0.009)	-3.436**
Proportion meat	0.17 (0.006)	0.265 (0.007)	-9.897***
Proportion of milk	0.27 (0.009)	0.131 (0.007)	11.973***

*Figures in brackets are standard errors. ** = significant at p < 0.01, *** = significant at p < 0.001.*

4.2.5 Household expenditure

Expenditure on staple food and transport was higher in the Kafue floodplain than in the Lower Shire floodplain while expenditure on education and medical bills was lower in the Kafue floodplain than in the Lower Shire floodplain ($p < 0.001$; Table 4.5).

Table 4.5: Expenditure per month (US$) by household in the Kafue and the Lower Shire floodplains, 2007/2008

	Kafue floodplain	**Lower Shire floodplain**	**t-test**
Mean	n = 891	n = 1044	
Cereal grain (staple food)	15.96 (0.662)	7.39 (0.395)	11.118***
Transport	6.03 (0.239)	1.74 (0.137)	15.585***
Education	6.99 (0.72)	26.962 (1.54)	-11.704***
Medical	1.704 (0.125)	4.461 (0.194)	-11.906***

*Figures in brackets are standard errors. *** = significant at p < 0.001.*

4.2.6 Correlation between assets, alternative sources of income and fishing time

Table 4.6 shows that land holding size, number of cattle owned, income from farming, income from livestock and income from off-farm activities had a significant negative correlation with time spent fishing in the Kafue floodplain while land holding size, number of cattle owned, income from farming and income from livestock had insignificant correlation with time spent fishing in the Lower Shire floodplain. Only income from off-farm activities had significant positive relationship with time spent fishing in Lower Shire floodplain.

Table 4.6: Linear relationships between level of time in fishing and assets and alternative sources of income in fishing households of Kafue and Lower Shire floodplains, 2007/ 2008.

	Kafue floodplain (n = 708)		***Lower Shire floodplain (n = 324)***	
Dependent variable: Time spent fishing per month (hours) against:	**r**	***p***	**r**	***p***
Total land holding size (ha)	-0.246	< 0.001	-0.064	> 0.05
Number of cattle owned (heads)	-0.141	< 0.001	0.054	> 0.05
Farming income per month (US$)	-0.273	< 0.001	0.045	> 0.05
Livestock income per month (US$)	-0.166	< 0.001	0.031	> 0.05
Off-farm income per month (US$)	-0.091	< 0.05	0.144	< 0.001

4.2.7 Level of income poverty and economic vulnerability

Both income poverty and economic vulnerability were higher in the Kafue floodplain than the Lower Shire floodplain irrespective of whether fishing income was included or exclude from the analysis ($t_{PHCnofishincome}$ = -111.099, $p < 0.001$, $n_{LowerShire}$ = 482, n_{Kafue} = 745; $t_{PHCfishincome}$ = -60.253, $p < 0.001$, $n_{LowerShire}$ = 381, n_{Kafue} = 694; $t_{EVnofishincome}$ = -11.944, $n_{LowerShire}$ = 1040, n_{Kafue} = 604; $t_{EVfishincome}$ = -7.839, $n_{LowerShire}$ = 1040, n_{Kafue} = 604; respectively; Figure 4.1).

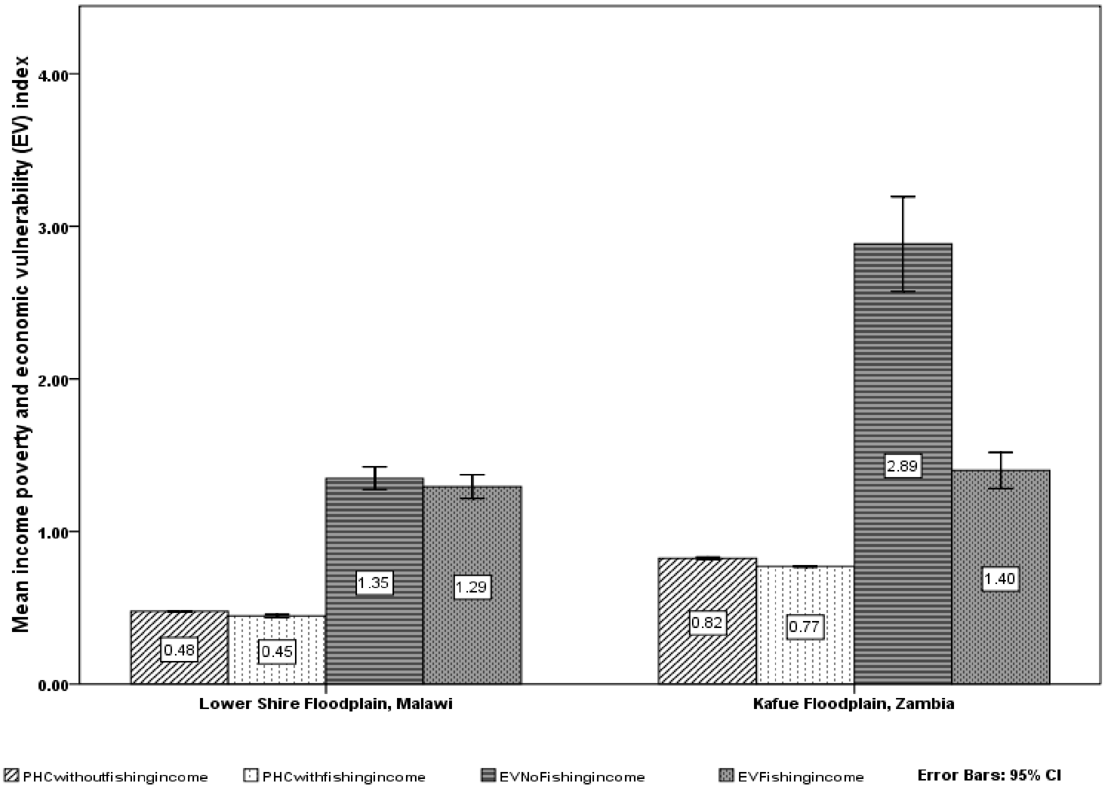

Figure 4.1: Effect of fishing income on income poverty and economic vulnerability in the Kafue and the Lower Shire floodplains, 2007/2008.

4.3 DISCUSSION

4.3.1 Comparison of household labour allocation between fishing and farming

The results showed that households in the Kafue floodplain spent more time in fishing while households in the Lower Shire floodplain spent more time in farming suggesting that fishing was the main occupation among the Kafue floodplain communities while farming was the main occupation among the Lower Shire floodplain communities (Table 4.1). This was also supported by lower farming productivity in the Kafue floodplain than in the Lower Shire floodplain (Table 4.2). Earlier results also indicated that there were more specialised fishers and livestock pastoralists in the Kafue floodplain (Table 2.1) while there were more specialised farmers and part-time fishers in the Lower Shire floodplain (Table 3.1). The findings implied that fishing in the Kafue floodplain provided a labour buffer to households while fishing was part of a diversified livelihood strategy in the Lower Shire floodplain.

In most inland small-scale fisheries, particularly in sub-Saharan Africa floodplains, farming households that also engage in fishing as a part time activity are usually better integrated in the rural economy than fishing households that also engage in farming as a part time activity (Malasha 2007). Often times, the later are usually found in isolated remote areas where social services are also inadequate (Malasha 2007, Béné 2006, WFC 2004). The current analysis demonstrated that where farming was the predominant activity like the case of the Lower Shire floodplain, levels of formal education and subsequent expenditure on education were higher than where fishing was the predominant activity like the case of the Kafue floodplain where subsequent expenditure on transport was higher (Table 4.1 and Table 4.5).

4.3.2 Comparison of socio-economic characteristics of households

The results indicated that heads of households in the Kafue floodplain were relatively older but with a shorter residence in the floodplain than those in the Lower Shire floodplain (Table 4.1). The findings supported earlier observations which showed that the fishing communities in the Kafue floodplain were mainly immigrants while those of the Lower Shire floodplain were mainly locals (Tables 2.1 and 3.1). Haller and Merten (2005) also indicated that the fishing community in the Kafue floodplain was mainly dominated by households that were retrenched in the copper mines while the focus group discussions in the Lower Shire floodplain revealed that immigrants were restricted from direct fishing and were only allowed to participate as fish traders.

The results implied that where the fishery is in a state of open access with weaker management regime like in the Kafue floodplain, the fishery effectively performs a safety net function to immigrant households with no viable livelihood option while where the fishery is in a state of open access with stronger management regime like in the Lower Shire floodplain, the fishery effectively performs a risk spreading function to local residents seeking to diversify their livelihood options. This was also supported by results in Table 4.3 which indicated that fishing was the main sources of household income in the Kafue floodplain unlike in the Lower Shire floodplain where farming was the main source of household income.

4.3.3 Comparison of household assets

The findings showed that households in the Kafue floodplain had smaller land holding sizes but more cattle and higher fish catch per month than households in the Lower Shire floodplain (Table 4.2) in line with earlier results in Table 4.1. Larger landholding size was associated with higher farming production in the Lower Shire floodplain (Table 4.2) while it was associated with less time spent fishing in the Kafue floodplain (Table 4.6). Besides fishing, the Kafue floodplain community also undertake substantial cattle rearing, an observation which has also been alluded to by Haller and Merten (2005) but households with larger number of cattle spent less time in fishing (Table 4.6). In addition, both higher income from farming and livestock were associated with less time in fishing in the Kafue floodplain unlike in the Lower Shire floodplain (Table 4.6).

The findings suggested that fishing in the Kafue floodplain was mainly undertaken by households with fewer assets and was the main livelihood strategy among households in the Kafue floodplain unlike in the Lower Shire floodplain. Common property resources such as fisheries have also been reported to play a significant livelihood role among households with limited or near landless in sub-Saharan Africa (Béné *et al*. 2009, Chirwa 2008, Jayne *et al.* 2006).

4.3.4 Comparison of main source of income and animal protein

Fishing was the main source of income among households in the Kafue floodplain while farming was the main source of income among households in the Lower Shire floodplain (Table 4.3) but fishing was the main source of animal protein in both floodplains and contributed significantly higher proportion to animal protein consumption in the Lower Shire floodplain than in the Kafue floodplain (Table 4.4). The results also showed that households in the Kafue floodplain had significantly higher income per month than those in the Lower Shire floodplain implying that fishing in the Kafue floodplain was a major source of income security while it was the major source of nutrition security in the Lower Shire floodplain.

In addition, time spent fishing decreased with increasing income from farming, livestock and off-farm activities in the Kafue floodplain while it increased with increasing income from off-farm activities in the Lower Shire floodplain suggesting that fishing income supports off-farm activities and vice versa (Table 4.6). The results conform to earlier findings that indicated that fishing performed a safety net function in the Kafue floodplain while it performed a risk spreading function in the Lower Shire floodplain.

Households in the Kafue floodplain also displayed higher expenditure on staple food (Table 4.5) suggesting that fishing income made significant contribution to food purchase it being the major source of household income in fishing households of the Kafue floodplain where farming productivity was lower. A number of studies have also concluded that the capacity to attain food security through the market is strongly correlated to the level of income, availability of the food and access to the food (GoM 2006, NSO Malawi 2005, Swindale and Bilinsky 2005, Hoddinott *et al*. 2002, IFPRI 2001, CSO Zambia 2000, USAID 1992). Since fishing was the major source of income in the Kafue floodplain, it is plausible to presume that such income played an important role in ensuring household food security in the floodplain. Similar role played by fisheries has also been reported by Béné *et al*. (2009) in Congo DRC.

4.3.5 Comparison of the effect of fishing income on poverty and vulnerability reduction

The findings showed that income poverty and economic vulnerability were higher in the Kafue floodplain than in the Lower Shire floodplain both with and without fishing income (Figure 4.1). With fishing income, income poverty head count decreased by 6 per cent ($p < 0.001$) and economic vulnerability decreased by 52 per cent ($p < 0.001$) in the Kafue floodplain. In the Lower Shire floodplain, income poverty head count decreased by 6 per cent ($p < 0.05$) and economic vulnerability decreased by 4 per cent ($p < 0.05$) with fishing income.

The current results also demonstrated that although the Kafue floodplain communities had higher income per month, they experienced higher poverty and vulnerability than the communities in the Lower Shire floodplain. The results implied that the poverty and vulnerability problem in the Kafue floodplain may be structural or chronic in nature with a number of dimensions including deterioration in the macro-economic conditions such as higher inflation (Appendix D) which erodes the purchasing power parity of local income. The results were in line with conclusions by other authors that indicate that poverty and vulnerability are multidimensional (Béné 2009, Hogan and Marandola 2005, Prowse 2003).

4.4 SUMMARY

The analysis showed that fishing is the main sources of income and provided a fall-back strategy in the Kafue floodplain to households who have less land but more cattle while it is a complementary source of income and provided a risk spreading strategy in the Lower Shire floodplain to households who have more land but fewer cattle. The fact that farming productivity was much lower in the Kafue floodplain also showed that the area was clearly more suited to livestock than farming, and so, unsurprisingly, livestock husbandry is the traditional activity in the Kafue floodplain. Consequently, time spent fishing in the Kafue floodplain increases with declining income from livestock while it increases with increasing income from off-farm activities in the Lower Shire floodplain.

In both floodplains, fishing is the main source of animal protein security. Based on these findings, fishing pressure is likely to increase on the Kafue floodplain fishery as a result of new entrants from disfranchised households in the formal sector with less land and fewer cattle while fishing pressure is likely to increase in the Lower Shire floodplain as a result of population growth and declining farming land. The analysis also showed that predominantly fishing households in the Kafue floodplain were more income poorer and economically vulnerable than predominantly farming households in the Lower Shire floodplain.

CHAPTER FIVE: SYNTHESIS, CONCLUSIONS AND RECOMMENDATIONS

5.1 SYNTHESIS OF FINDINGS

The chapter synthesises findings in Chapters Two through Four in order to address the overall hypotheses of the study as outlined in Chapter One. Major conclusions and recommendations from the synthesis are also presented.

5.1.1 The relationship between fishing and level of asset holding

The analysis has shown that there are more specialised fishers in the Kafue floodplain while there are more specialised farmers in the Lower Shire floodplain and as a result the proportion of fishing households is higher in the Kafue floodplain while the proportion of farming households is higher in the Lower Shire floodplain. In the Kafue floodplain, time spent fishing is higher among households that have smaller land holding sizes, fewer cattle and more household labour while households with larger family sizes, more labour from male members and higher income from off-farm activities allocate more time to fishing in the Lower Shire floodplain. In both floodplains, fishing is the main source of income and animal protein among fishing households. At community level, fishing remains the main source of income in the Kafue floodplain community while it is a complementary source of income to farming in the Lower Shire floodplain community but in both communities, fishing remains the major source of animal protein.

The socio-economic analysis demonstrated that local residents in the Kafue floodplain were traditionally pastoralists with low farming productivity and most of the fishing households were immigrants with fewer assets unlike in the Lower Shire floodplain where the local residents were traditionally farming households with higher farming productivity and also participated in fishing as a risk spreading strategy. The analysis addresses the data poor environment characterising the fishing communities in the two floodplains and in most sub-Saharan Africa floodplain fisheries (Béné 2009, Neiland and Béné 2008, Béné 2006, FAO 2006, WFC 2005). The analysis therefore contributes to better understanding of the nature of fishing households in floodplains which would improve decision making process when designing fisheries management strategies.

5.1.2 The effect of fishing on income poverty and economic vulnerability

The study makes significant contribution to current poverty and vulnerability literature in fishing communities (Béné 2009, Barrett *et al.* 2006, Ellis and Freedman 2005, Béné 2003, Béné *et al*. 2003, Allison and Mvula 2002, Allison and Ellis 2001) by eliciting the welfare value of fishing in the two floodplains. The study addresses the data poor environment regarding poverty and vulnerability in fishing communities of the two floodplains by assessing the level of poverty and vulnerability using *'with and without'* fishing income scenarios which directly capture and demonstrate the welfare value of fishing in a manner that can easily be understood by policy makers.

The analysis showed that both poverty and vulnerability reduced with fishing income in both floodplains. In the Kafue floodplain, income poverty head count decreased by 6 per cent and economic vulnerability decreased by 52 per cent with fishing income. In the Lower Shire floodplain, income poverty head count decreased by 6 per cent and economic vulnerability decreased by 4 per cent with fishing income. However, the prevalence of poverty in specialised fishing households of the Kafue floodplain was still higher than in specialised farming households even with fishing income while economic vulnerability was lower in specialised fishing households as compared to specialised farming households with fishing income. Specialised fishing households in the Kafue floodplain are therefore poorer but less vulnerable with fishing income. The results in the Lower Shire floodplain showed that both poverty and vulnerability were lower in fishing households than in specialised farming households both with and without fishing income. Fishing households in the Lower Shire floodplain were therefore both better-off and less vulnerable than specialised farming households.

At community level, both poverty and vulnerability were higher in the Kafue floodplain than in the Lower Shire floodplain either with or without fishing income. The study provides further impetus towards understanding income poverty and economic vulnerability in floodplain fisheries. Where there is heavy reliance on fishing as a core source of income, both poverty and vulnerability are higher (the case of the Kafue floodplain community) while where fishing is undertaken as part of a livelihood diversification strategy, both poverty and vulnerability are lower (the case of the Lower Shire floodplain community). The poverty and vulnerability problem in the Kafue floodplain could also be due to other dimensions of poverty including social service and infrastructural constraints (Malasha 2007). The findings in the Kafue floodplain also provide further evidence that poverty and vulnerability may be related but are not necessarily synonymous (Hoogeveen *et al*. 2006, Prowse 2003) while the results in the Lower Shire floodplain show that livelihood diversification is a necessary strategy for poverty and vulnerability alleviation in rural areas (Ellis 2000).

5.1.3 Open access, management regime and welfare function of fisheries

In both floodplains, the fisheries are in a state of open access and the departments of fisheries regulate mesh size, gear licensing and closed season in the case of the Kafue floodplain. However, enforcement of regulations is relatively weaker in the Kafue floodplain due to poor patrolling of the fishing camps by the department of fisheries staff and absence of legally recognised co-management (Malasha 2007) while enforcement of regulations is relatively stronger in the Lower Shire floodplain where there is also legally recognised co-management (Njaya 2007). In addition, there are also informal restrictions to entry into the fishery in the Lower Shire floodplain resulting in informal private access rights to the fisheries resource. The study found that fishing in the Kafue floodplain where open access is associated with weaker management regime effectively performs a safety net function to immigrant households with fewer assets while it performs a risk spreading function in the Lower Shire floodplain where open access is supported by a stronger management regime.

The analysis further showed that social protection value (Table 1.1) of fishing in both floodplains was equivalent to over half of the minimum daily wage rate stipulated by government for rural workers and almost the same as daily wage rate paid by richer neighbours in the communities. Fishing effectively subsidises government expenditure on social protection in the two floodplains by providing regular cash income to households. Such a function has significant budgetary effect especially in low income countries like Zambia and Malawi where national budgets depend on foreign support. Fishing therefore plays a significant indirect budgetary support in developing countries by reducing the number of households that would otherwise require safety nets from the government. In line with the social protection value, the analysis also showed that fishing households in the Kafue floodplain accumulate assets over time which serve as stepping stones out of the fishery and consequently out of poverty. The findings in the study provide missing information regarding the link between fisheries management objective and the welfare value of fisheries. The study has shown that where fisheries management objective is people-centred; fishing plays a safety net role like in the Kafue floodplain and where fisheries management objective is resource-centred; fishing plays a risk spreading role like in the Lower Shire floodplain.

5.1.4 The effect of rainfall variability on welfare function of fisheries

The analysis showed that fish production was correlated with local rainfall variability in the 1980s and has since then been uncorrelated to local rainfall variability in both floodplains. Both fishing and agricultural production are negatively affected by droughts and fish production situation is further impacted by other factors such as overfishing, use of inappropriate fishing gear and methods. In both floodplains, fish production and per capita fish production have declined over the past two decades. The analysis demonstrated that fishing as a livelihood strategy is under threat in both floodplains due to droughts, environmental changes and human factors.

The trend in per capita agricultural production is equally downward except between 1995 and 2000 for maize production in the Lower Shire floodplain. This is likely to increase pressure on the fisheries in the two floodplains due to population growth and declining farming land as the open access nature of the fisheries would attract more entrants seeking alternative livelihood options. As a result, there would be more effort which would eventually reduce catch per unit or '*too many people chasing too few fish*' leading to diminishing welfare function performed by the fisheries. The declining trends in both fisheries and agricultural production signal a production system that is stressed and highly vulnerable. It is imperative that fisheries management strategies in both floodplains should take on board the trends in other related sectors forming the livelihood systems of the two floodplain communities.

5.2 CONCLUSIONS AND RECOMMENDATIONS

5.2.1 Fishing in the floodplains is mainly undertaken by land constrained households

There were clear differences between communities in the Kafue and the Lower Shire floodplains in terms of their level of involvement in fishing and reliance on fishing as a source of income. The immigrant residents in the Kafue floodplain community displayed higher involvement in fishing and reliance on fishing as the main source of income while the residents in the Lower Shire floodplain community displayed higher involvement in farming and reliance on farming as the main source of income. This was also demonstrated by higher livestock production in the Kafue floodplain among locals and higher agricultural production in the Lower Shire floodplain than in the Kafue floodplain. Fishing is however, the main source of animal protein in both floodplain communities. Consequently, fishing is mainly undertaken by immigrant households with smaller land holding size, lower income from livestock and higher household labour in the Kafue floodplain while it is mainly undertaken by households with smaller land holding sizes, higher labour from males and higher income from off-farm activities in the Lower Shire floodplain. Fishing is therefore an activity mainly undertaken by land constrained households in both floodplains, among other socio-economic factors.

5.2.2 Fishing reduces income poverty and economic vulnerability

The study found that in the Kafue floodplain, income poverty is higher but economic vulnerability is lower in fishing households than in specialised farming households; and in the Lower Shire floodplain, both income poverty and economic vulnerability are lower in fishing households than specialised farming households. The study also found that the Kafue floodplain fishing communities are also trapped in many dimensions of poverty including poor education facilities, poor health and sanitation facilities, marginalization and poor road infrastructure while the Lower Shire floodplain fishing communities have a diverse base of livelihood strategies in which fishing has a smoothing effect on seasonal shortfalls in farming income. It is imperative in the case of the Kafue floodplain that poverty alleviation and fisheries resource management strategies should take a holistic and multi-sectoral approach and the department of fisheries should deliberately collaborate with other sectors in rural development to communicate the welfare value provided by the fisheries.

In both floodplains, fishing income reduced poverty and vulnerability and made substantial contribution to welfare and social protection value. The effect of fishing income on poverty and vulnerability in the Kafue floodplain shows that poverty and vulnerability are related but not identical while the effect of fishing income in the Lower Shire floodplain shows that fishing is an effective livelihood strategy in combating poverty and vulnerability when combined with other livelihood strategies. At community level, households with higher involvement in fishing and reliance on fishing for income such as those in the Kafue floodplain are both poorer and vulnerable than households with higher involvement in farming and reliance on farming for income such as those in the Lower Shire floodplain. The level of poverty and vulnerability is however significantly influenced by the macro-economic conditions prevailing in the country.

The findings in the Kafue floodplain support the earlier views that fishers are the poor of the poorest. However, with longer stay in the Kafue floodplain, fishing provides an exit strategy out of poverty by enabling fishing households to accumulate assets. Further research using longitudinal data observed over the same households could provide more insights regarding the relationship between length of residence in the Kafue floodplain, accumulation of assets and poverty reduction.

5.2.3 Fishing performs safety net and risk spreading functions

The study demonstrated that open access with weaker management regime is essential for safety-net function while restricted access with stronger management regime is essential for risk spreading function both of which play an important role when households experience shocks such as loss of livestock or poor harvest due to droughts or floods. Fishing in the floodplains provides a ready and timely fall-back and coping strategy to households seeking alternative livelihoods after experiencing a shock. Fishing therefore effectively performs a safety net function in the Kafue floodplain for disenfranchised households that have immigrated into the area due to the open access and weaker management regime while it performs a risk spreading function in the Lower Shire floodplain where households are comparatively well-off in terms of their asset base and access is restricted through informal mechanism and stronger management regime.

Where fisheries management objective is to maximise equitable distribution of the resource, strategies that support open access to the resource would be necessary while where the fisheries management objective is to maximise economic returns, mechanisms that restrict access to the resource would be necessary. In the Kafue floodplain, interventions that also support alternative livelihood strategies outside the fisheries sector should also be promoted to relieve pressure on the fisheries resource and to conserve the stocks. In general, rural development policies including those targeted at fishing communities should aim at facilitating accumulation of productive non-fishing assets to enable households escape from poverty traps and heavy reliance on fisheries resource. Such policy measures could include increased access to credit, increased access to land and livestock and by promoting other income generating opportunities.

5.2.4 Droughts negatively affect welfare value of fisheries

The study has shown that in the Kafue floodplain, the effect of change in flooding regime has resulted in positive correlation between fish production and maize production implying that in the event of poor local rainfall both fish production and maize production would be simultaneously affected. In the Lower Shire floodplain, where the entire flooding regime is uncontrolled, fish production is negatively correlated with maize production implying that in the event of poor local rainfall fish production and maize production may not be affected simultaneously as long as the catchment of the floodplain receives adequate rains.

Fisheries resource would therefore provide an immediate coping strategy when local rainfall is poor in the Lower Shire floodplain than in the Kafue floodplain. Measures that reduce the likelihood of crop failure and ensure a steady supply of fish and livestock products in years of poor local rainfall should be promoted. These measures could include improved soil and water management, small-scale irrigation projects, adoption of drought-tolerant and early-maturing crop varieties, introduction of aquaculture and promotion of small livestock. Further research is still required to improve understanding of the impact of local rainfall variability and environmental changes on sustainability of the fish stocks and the welfare function performed by fisheries resource.

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APPENDICES

APPENDIX A: CHECK LIST

FOCUS GROUP DISCUSSION AND KEY INFORMANT INTERVIEWS

1. Who are the primary, secondary and tertiary stakeholders in:
    i. Fisheries
    ii. Farming
    iii. Livestock
    iv. Off-farm activities
2. Ranking of main livelihood strategies:
    i. Farming
    ii. Fishing
    iii. Livestock
    iv. Off-farm
3. Describe the state of the fisheries in terms of:
    i. Fishing effort
    ii. Fish species diversity
    iii. Fish catches
    iv. Fish values
4. Explain the contribution of fisheries to:
    i. Household income
    ii. Household food security
    iii. Household nutrition security
5. Explain the seasonal and interannual relationship between:
    i. Fisheries and farming in terms of labour demand
    ii. Fisheries and farming in terms of cash needs
    iii. Fisheries effort and farming output
    iv. Water changes and fisheries values

APPENDIX B: HOUSEHOLD QUESTIONNAIRE

THE WELFARE VALUE OF INLAND SMALL-SCALE FLOODPLAIN FISHERIES OF THE ZAMBEZI RIVER BASIN

Questionnaire number Malawi __________ Zambia __________

DETAILS OF INTERVIEWER

Name of enumerator ________________
Contact cell/phone ________________
Date of interview ____/____/_______
Country ________________
District ________________
Traditional Authority ________________
Village ________________

Start time ________________ End time ___________

Interview result code

1 = questionnaire completed
2 = questionnaire not completed
3 = interview not conducted

Instructions from supervisor to research assistant:
………
………

INTRODUCTORY REMARKS

My name is ….. and I am working with the Department of Fisheries in conjunction with the University of Cape Town and World Fish Centre to conduct a survey on the valuation of fisheries. Your household is one of the households that have been randomly selected of all households in this village to be asked the questions in this survey. I would very much appreciate your participation in this survey. I would like to ask you about food, income, employment, fisheries, agriculture, among other things. This information will help government, research institutions and other stakeholders like you to better understand the values of fisheries. This will assist stakeholders to better manage fisheries resources for sustainable contribution to household food security and poverty alleviation. What ever information you provide will be strictly confidential and will not be shown to other people.

MODULE 1: HOUSEHOLD DETAILS

1. What is the size of the household (ask the number of people being looked after by the household head, including him/herself) ______

2. Record the,

   Number of adults (15 years or older) ______

   Number of children (5 – 14 years) ______

   Number of infants under 5 years ______

3. Record the following details about the household head:

Name	Age in years (e.g. 29)	Sex (circle)	Marital status (circle)	Years of formal education (e.g. 3)	Level of literacy (circle)
		1 = Male 2 = Female	1 = Not married 2 = Married		1 = Illiterate 2 = Literate

Ask the household head to write his/her name, name of any famous politician, dates or numbers

4. For how long has the household head been continuously living in the floodplain? (record years e.g. 3 years). ____________________

5. Why has the household head stayed this long in the floodplain? ___________________________________

6. Where did the household head live before moving to the floodplain? ______________________________

7. Why did the household head leave the former place of residence? ________________________________

8. What did the household head get after moving to the floodplain? __________________________________

MODULE 2: HOUSEHOLD PRODUCTIVE ASSETS

A. Household land asset

Note: Malawi: 1 ha = 2.4 acres; Zambia: 1 ha = 4 limas

1. What is the total land holding size of the household?	acres/limas
2. How much land did the household rent for cultivation during the last cropping season?	acres/limas
3. How much of own land was cultivated in the last cropping season?	acres/limas
4. How much of the cultivated land was under irrigation?	acres/limas
5. List the main staple food crops that the household planted in the last cropping season?	
6. How much land was planted with each staple food crop mentioned in 5 during the last cropping season?	

Name of staple	acres/limas
7. How many kilograms of each staple food crop did the household harvest in the last cropping season?	
Name of staple	kg
8. How many kilograms of each staple food crop were used for home consumption?	
Name of staple	kg
9. List the names of cash crops that the household planted during the last cropping season?	
10. How much land was planted to each cash crop in the last cropping season?	
Name of cash crop	acres/limas
11. How many kilograms of each cash crop did the household harvest in the last cropping season?	
Name of cash crop	kg
12. How many kilograms of the each cash crop did the household sell in the last cropping season?	
Name of cash crop	kg

B. Household livestock asset

Fill in the details for the different types of livestock that the household is keeping					
Type of livestock	Number at present	Number sold LAST MONTH	Number consumed LAST MONTH	Number sold LAST YEAR	Number consumed LAST YEAR
Cattle					
Goats					
Sheep					
Pigs					
Poultry					
Milk produced (liters)	NA				
Eggs produced	NA				

C. Household labour asset

1. What is the main (preferred) occupation of the household head?	
2. What is the most important occupation of the household head in terms of household income?	

3. What is the main (preferred) occupation of the husband?	
4. What is the most important occupation of the husband in terms of household income?	

5. How much time was spent by the ADULT MEN on the following activities LAST MONTH?			
Activity	Number of adult males involved last month	Person-days last month (e.g. 2 men x 5 days + 1 man x 2 days = 12 days)	Typical hours per day in that activity
Farming			
Fishing			
Fish processing			
Fish trading			
Trading in agricultural products			
Gear and fishing craft construction			
Other Business			
Formal employment			
Piece work (in fishing)			
Piece work (in farming)			

6. What is the main (preferred) occupation of the wife?	
7. What is the most important occupation of the wife in terms of household income?	

8. How much time was spent by the ADULT WOMEN on the following activities LAST MONTH?			
Activity	Number of adult women involved last month	Person-days last month (e.g. 2 women x 5 days + 1 woman x 2 days = 12 days)	Typical hours per day in that activity
Farming			
Fishing			
Fish processing			
Fish trading			
Trading in agricultural products			
Gear and fishing craft construction			
Other Business			
Formal employment			
Piece work (in fishing)			
Piece work (in farming)			

MODULE 3: HOUSEHOLD SOURCES OF INCOME

1. How much cash income did the household earn from the following sources?		
Source of income	Income earned during LAST MONTH (MK/ZMK)	Income earned during LAST YEAR (MK/ZMK)
I. Fishing		
Sale of fish		
Sale of fishing gear and fishing craft		
Casual employment in fisheries activities		
II. Farming		
Sale of food crops		
Sale of cash crops		
Sale of fruits and vegetables		
Casual employment in farming activities		
III. Livestock		
Sale of livestock		
Sale of livestock products		
IV. Off-farm activities		
Petty trade		
Business		
Other employment		

2. Ask the household head to rate the sources of income using beans or maize grain or stones etc. by distributing them among different sources of income by placing more beans or maize grain or stones etc. on the most important source of income and less beans or maize grain or stones etc. on the least important source of income during the last five years.

2. Ranking of income sources for the past five years	
Activity	Rank during last FIVE YEARS
I. Fishing	
Sale of fish	
Sale of fishing gear and fishing craft	
Casual employment in fisheries activities	
II. Farming	
Sale of food crops	
Sale of cash crops	
Sale of fruits and vegetables	
Casual employment in farming activities	

III. Livestock	
Sale of livestock	
Sale of livestock products	
IV. Off-farm activities	
Petty trade	
Business	
Other employment	

MODULE 4: HOUSEHOLD EXPENDITURE

A. Expenditure on food items

1. Did the household buy maize during		
LAST MONTH (circle)	1 = YES	2 = NO
LAST YEAR (circle)	1 = YES	2 = NO

2. If the answer is YES in 1, how many kilograms of maize did the household buy during	
LAST MONTH	kg
LAST YEAR	kg

3. How much of each of the following food items were consumed by the household?			
List	Amount consumed LAST WEEK	Amount consumed LAST MONTH	Amount consumed LAST YEAR
Maize (kg)			
Rice (kg)			
Sorghum (kg)			
Millet (kg)			
Meat (kg)			
Fish (kg)			
Eggs (#)			
Milk (liters)			

4. How much did the household spend on each of the following food items?		
Items	Amount spent LAST MONTH (MK/ZMK)	Amount spent LAST YEAR (MK/ZMK)
Staples		
Animal products		
Fats and oils		
Fruits and vegetables		
Roots and tubers		
Legumes (Pulses)		

B. Expenditure on non-food items

5. How much did the household spend on each of the following FARMING INPUTS?		
Item	Amount spent LAST MONTH (MK/ZMK)	Amount spent LAST YEAR (MK/ZMK)
Fertilizer		
Seed, planting materials		
Tools		
Land rent		
Labor		
Processing costs		
Trading costs		

6. How much did the household spend on each of the following FISHING INPUTS?		
Item	Amount spent LAST MONTH (MK/ZMK)	Amount spent LAST YEAR (MK/ZMK)
Gear		
Craft		
Gear rent		
Craft rent		
Labor		
Processing costs		
Trading costs		

7. How much did the household spend on each of the following HOUSEHOLD AMMENITIES?		
Item	Amount spent LAST MONTH (MK/ZMK)	Amount spent LAST YEAR (MK/ZMK)
Clothing, blankets and footwear		
Soap and body care		
Firewood and charcoal		

Paraffin and matches		

8. How much did the household spend on each of the following household SOCIAL SERVICES?		
Item	Amount spent LAST MONTH (MK/ZMK)	Amount spent LAST YEAR (MK/ZMK)
Transport		
Children education		
Medical and health care		
Communication		

9. How much did the household spend on each of the following ASSETS?		
Item	Amount spent LAST MONTH (MK/ZMK)	Amount spent LAST YEAR (MK/ZMK)
House		
Furniture		
Radio, batteries, parts		
Bicycle and bicycle parts		
Land		
Livestock		
Oxcart		

10. How much did the household spend on each of the following household OTHERS?		
Item	Amount spent LAST MONTH (MK/ZMK)	Amount spent LAST YEAR (MK/ZMK)
Paying loans		
Paying dowry		

MODULE 5: HOUSEHOLD RISKS

A. Food insecurity and coping strategies

1. How many kg of staple food does the household currently have in stock?	kg
2. How many kg of staple food did the household receive as relief food last month?	kg
3. How many kg of staple food did the household receive as piece work pay last month?	kg

Coping strategies to food insecurity adopted (circle)		
4. Did any household member work in other peoples' fields in the last one month to get staple food?	1 = YES	2 = NO
5. Did any household member work in any other unwanted job in the last one month to get staple food?	1 = YES	2 = NO
6. Did the household sell or rent out land or/and livestock in the last one month in order to buy staple food?	1 = YES	2 = NO
7. Did the household sell or rent out any fishing gear or/and fishing craft in the last one month in order to buy staple food?	1 = YES	2 = NO
8. Did the household sell or rent out any other asset in the last one month in order to buy staple food?	1 = YES	2 = NO
9. Did the household reduce staple food portions at meal times in the last one month?	1 = YES	2 = NO
10. Did the household reduce number of meals per day containing staple food in the last one month?	1 = YES	2 = NO
11. Did the adults reduce consumption of staple food in the last one month so that children can eat more?	1 = YES	2 = NO
12. Did the household rely on less preferred types of foods in the last one month? (e.g. maize bran, fruits only, vegetables only, wild foods etc.)	1 = YES	2 = NO
13. Did school children stay at home in the last one month due to lack of staple food?	1 = YES	2 = NO
14. How many days did the household experience a shortage of staple food last month?	days	
15. How many days did the household miss meals of staple food in the last one month?	days	
16. How many meals of staple food did the household have yesterday?	meals	

B. Job insecurity

1. For how long has the household head been engaged in the current occupation?	
2. Before picking up the current occupation, what was the occupation of the household head?	

3. Between fishing and farming, which occupation does the household head think is (circle)		
more income secure?	1 = Farming	2 = Fishing
more income rewarding?	1 = Farming	2 = Fishing

Income insecurity

1. Did the household take any loans (cash or commodity) last month?	1 = YES	2 = NO
2. If yes, how much in total?	MK/ZMK	
3. Did the loan attract any collateral?	1 = YES 2 = NO	
4. If yes, what was the type of collateral?		
5. Did the loan attract any interest?	1 =YES 2 = NO	
6. If yes, how much was the rate of interest?		
7. What was the period for paying back the loan?		
8. Did you pay the loan using cash or commodity?		
9. From where did the household get the loan?	1 = Bank 2 = Moneylender 3 = Trader 4 = NGO 5 = Relative 6 = Club 99 = Others (specify)	
10. What was the reason for seeking the loan?	1 = Buy food 2 = Buy fertilizer 3 = Pay school fees 4 = Pay for hired labour 5 = Pay for medical bills 6 = Buy gear or craft 7 = Business expenses 8 = Buy household assets 99 = (Others, specify)	

MODULE 6: HOUSEHOLD FISHING DATA

1. What type of fishing craft is owned by the household	1 = Boat 2 = Boat with engine 3 = Dugout canoe 99 = Others (specify)

2. Provided details of fishing gear owned by the household				
Type of gear	Number (#)	Mesh size (mm)	Length (m)	Depth (m)
Seine net				
Cast net		XXXXXXXX	XXXXXXXX	XXXXXXXX
Fish traps		XXXXXXXX	XXXXXXXX	XXXXXXXX
Gill net				

Hand line		XXXXXXXX	XXXXXXXX	XXXXXXXX
Reed fence		XXXXXXXX		XXXXXXXX
Scoop net				
Long line		XXXXXXXX		

3. What was the QUANTITY and VALUE of fish caught from each of the fishing gear?						
Gear type	Quantity LAST WEEK (kg)	Value LAST WEEK (MK/ZMK)	Quantity LAST MONTH (kg)	Value LAST MONTH (MK/ZMK)	Quantity LAST YEAR (kg)	Value LAST YEAR (MK/ZMK)
Seine net						
Cast net						
Fish traps						
Gill net						
Hand line						
Reed fence						
Scoop net						
Long line						
Others						

THIS IS THE END OF MY QUESTIONS

1. Ask the respondent if he/she has questions and if yes, record the questions and your responses.
2. Ask the respondent if he/she has questions and if yes, record the questions and your responses.

THANK YOU FOR YOUR COOPERATION

APPENDIX C: INTER-ANNUAL DATA SETS

Year	Rainfall (mm)		Fish production (tons)		Maize production (metric tons)		Cattle production (# of herds)		Human population (# of persons)	
	Lower Shire	Kafue Flats	Lower Shire	Kafue Flats	Lower Shire	Kafue Flats	Lower Shire	Kafue Flats	Lower Shire	Kafue Flats
1960		757		2,450						
1961		730		3,940						
1962		963		5,640						
1963		912		7,040						
1964		781		7,980						
1965		649		6,600						
1966		840		6,090					266,307	
1967		630		2,890					274,260	
1968		833		4,880					282,451	
1969		806		5,720					290,887	496,000
1970		1,140		9,373			58,982		299,575	511,376
1971		713		8,296			64,904		308,522	527,229
1972		564		7,931			68,749		317,736	543,573
1973		963		6,129			75,119		327,226	560,423
1974		892		5,408			77,883		336,999	577,797
1975		855	9,658	7,266		380,154	84,057		347,064	595,708
1976		566	5,438	9,307		252,723	86,226		357,429	614,175
1977		1,053	5,600	9,830		415,134	89,289		371,162	633,215
1978		911	3,349	8,634		286,110	94,744		385,423	652,844
1979		968	3,778	10,851		470,439	94,743		400,231	663,083
1980		926	4,278	7,741		553,230	100,838		415,609	672,000
1981		582	5,226	9,619		207,630	104,469		431,577	690,144
1982		732	5,786	8,907		162,720	106,444		448,159	708,778
1983		684	4,922	3,605	23,400	144,630	108,955		465,378	727,915
1984		545	7,352	4,317	40,340	277,758	113,822		483,258	747,569
1985		874	9,041	5,008	42,480	387,037	122,275		501,826	767,753
1986	668	647	7,156	4,264	35,814	225,697	121,219		521,107	788,482
1987	903	687	8,179	5,955	51,762	538,830	210,397		524,755	809,771
1988	1,175	884	11,056	4,440	31,055	456,082	228,825		528,428	831,635
1989	699	787	6,996	8,569	45,494	287,456	239,163		532,127	854,089
1990	598	574	9,049	7,335	84,518	185,707	240,957		535,852	907,000
1991	359	396	2,957	5,362	14,396	25,215	241,754		539,603	927,861
1992	839	830	2,894	7,601	82,604	462,637	97,700		543,380	949,202
1993	613	464	1,747	8,724	69,045	193,605	95,608		547,184	971,033
1994	556	371	1,900	6,293	44,817	84,455	89,867	830,608	551,014	993,367
1995	1,124	759	1,848	6,479	152,058	286,532	90,569	815,815	554,871	1,016,215
1996	1,144	1,110	1,448	6,316	69,564	251,936	93,608	1,487,299	558,756	1,039,588
1997	822	552	1,620	6,137	164,119	149,386	72,056	742,697	551,606	1,063,498
1998	1,125	984	2,084	6,311	70,653	200,574	85,847	744,602	555,467	1,087,959
1999	849	1,035	1,602	5,946	131,071	251,946	85,401	797,636	564,327	1,112,982
2000	1,269	984	2,400	6,131	101,683	211,281	91,647	742,524	580,632	1,303,000
2001	745	602	2,200		96,691	63,093	89,883	572,344	597,084	
2002	762	571	1,950		93,566	127,277	90,600	573,646	613,820	
2003	594	1,279	1,700		77,495	211,976	93,810	539,227	643,159	
2004	504	820	1,600		32,221	120,518	91,687	555,403	660,956	
2005	821	655	1,575		91,393	230,105	95,035		679,265	

*blank cell indicates no data available

Sources:

Rainfall data: Metrological Department

Fish production data: Department of Fisheries

Maize production data: Ministry of Agriculture

Cattle production: Ministry of Agriculture

Population data: National/Central Statistical Office

APPENDIX D: RATES OF INFLATION

Year	Month	Malawi	Zambia
2007	January	9.6	9.8
	February	9.2	
	March	8.6	
	April	8.4	
	May	7.9	
	June	7.7	11.1
	July	7.4	11.2
	August	7.2	10.7
	September	7.1	9.3
	October	7.2	9
	November	7.4	8.7
	December	7.5	8.9
2008	January	7.7	9.3
	February	8	9.5
	March	8	9.8
	April	8.1	10.1
	May	7.9	10.9
	June	8.5	12.1
	July	8.7	12.6
	August	9.1	13.6
	September	9.3	
	October	9.4	
	November	9.6	
	December	9.9	
Average for the survey period		**8.2**	**10.4**

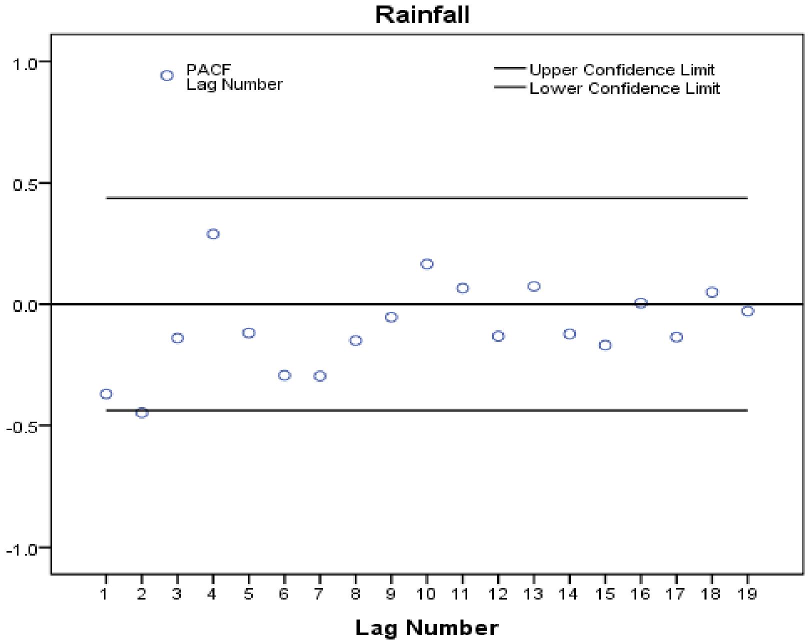
Sources:

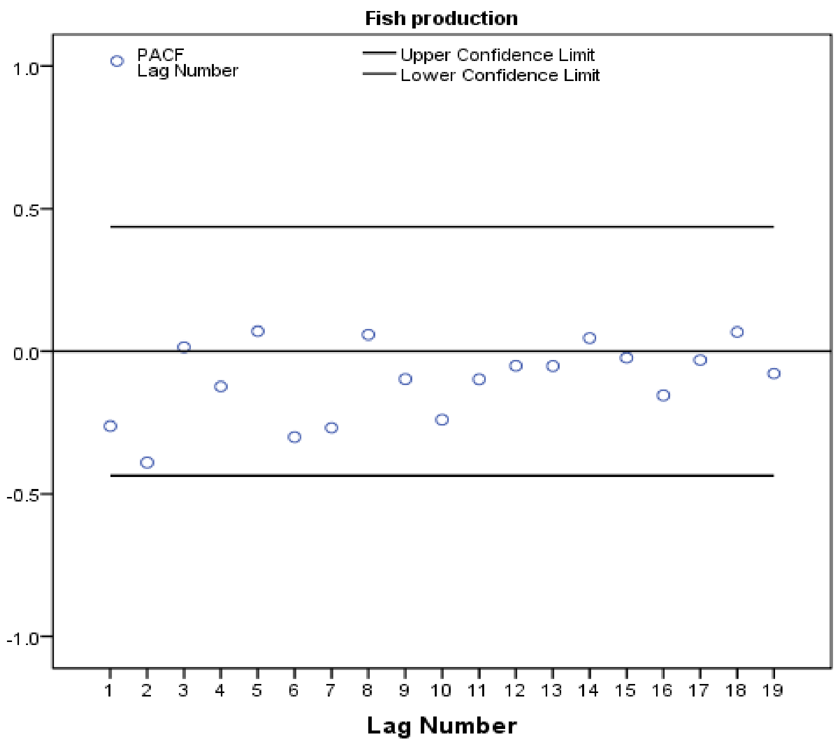
Malawi: http://www.nso.malawi.net

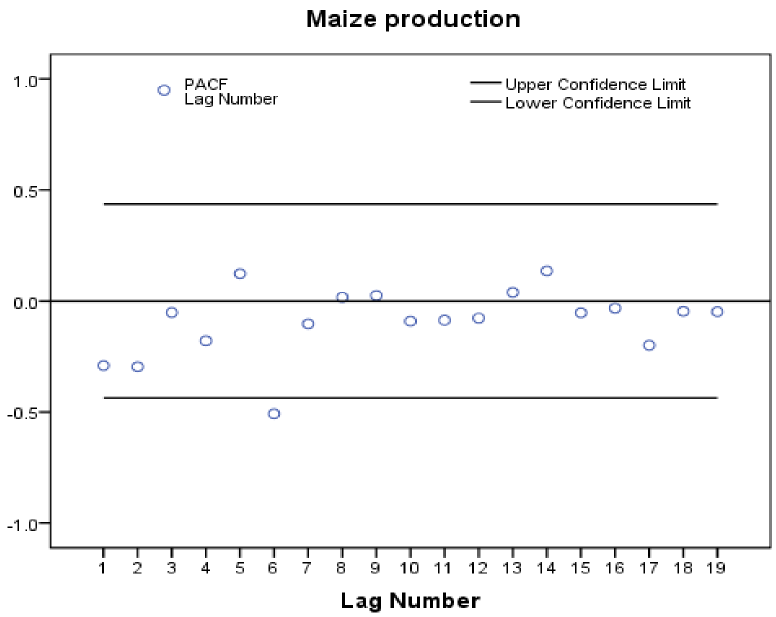
Zambia: http://www.zanstats.gov.za

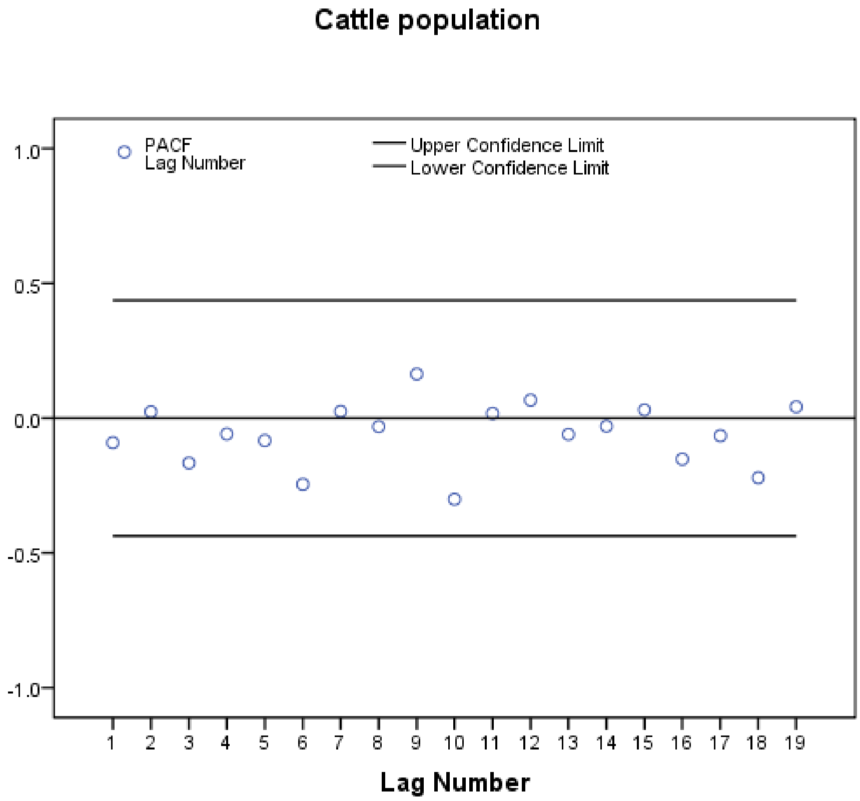
APPENDIX E: PARTIAL AUTOCORRELATION FUNCTIONS

Appendix E1: Tests for partial autocorrelation of time series data in the Kafue floodplain

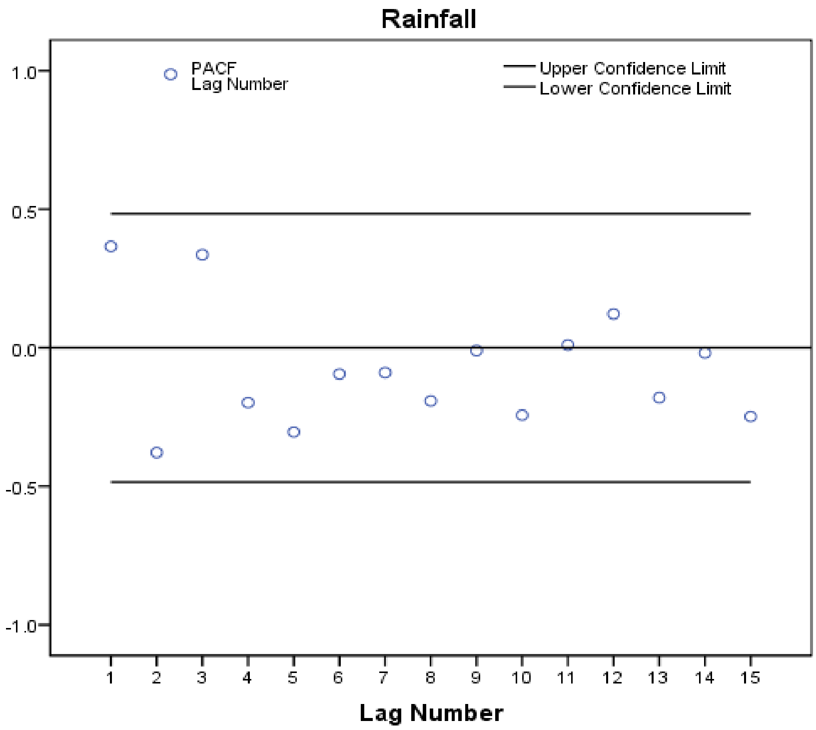


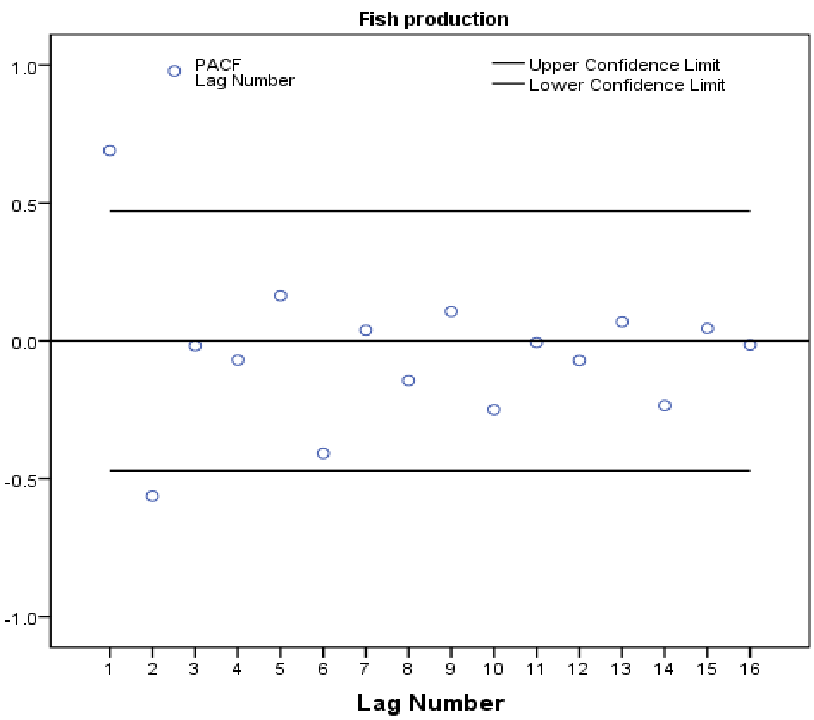


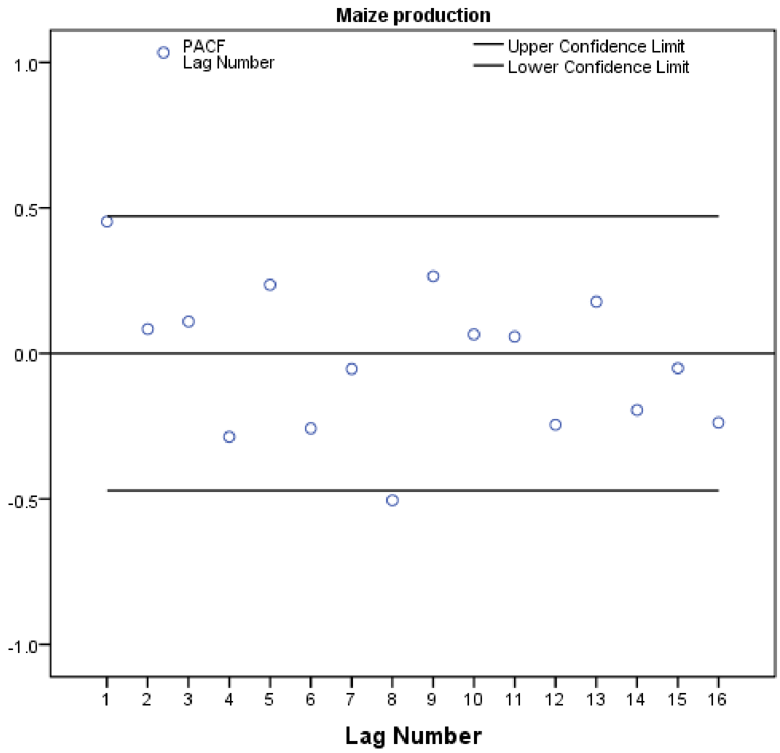

Maize production
PACF
Lag Number
Upper Confidence Limit
Lower Confidence Limit
1.0
0.5
0.0
-0.5
-1.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Lag Number

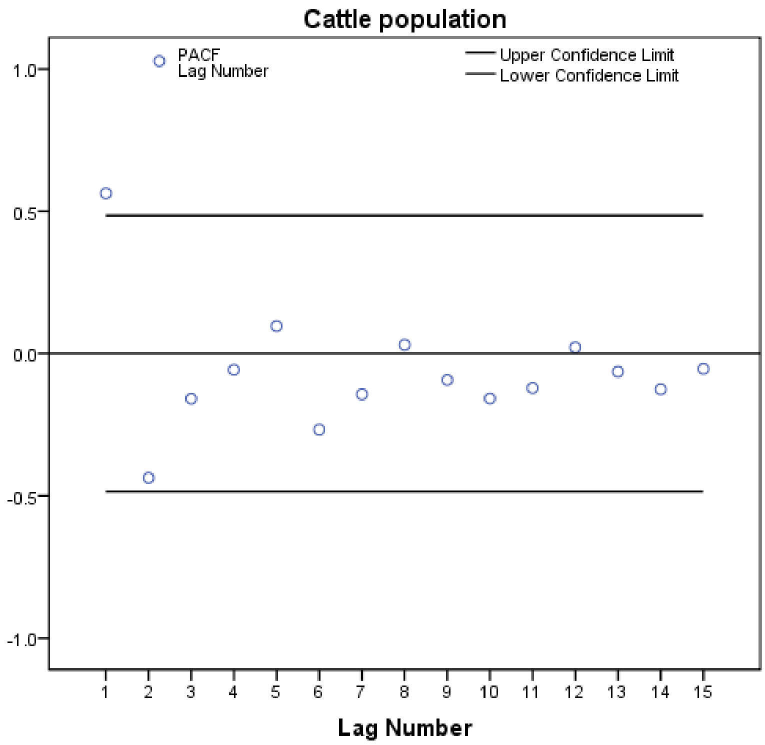

Cattle population
PACF
Lag Number
Upper Confidence Limit
Lower Confidence Limit
1.0
0.5
0.0
-0.5
-1.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19
Lag Number

Appendix E2: Tests for partial autocorrelation of time series data in the Lower Shire floodplain



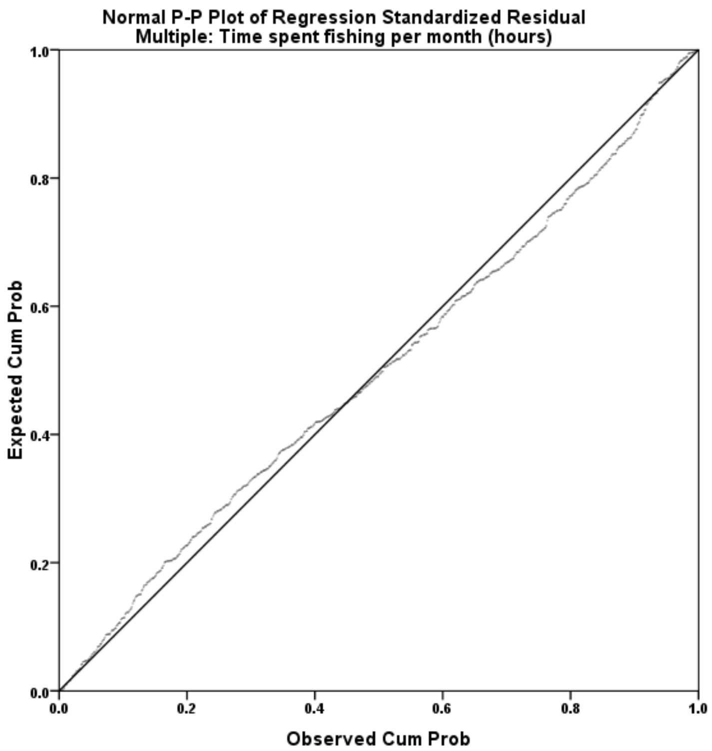



Maize production
PACF
Lag Number
Upper Confidence Limit
Lower Confidence Limit
1.0
0.5
0.0
-0.5
-1.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16
Lag Number

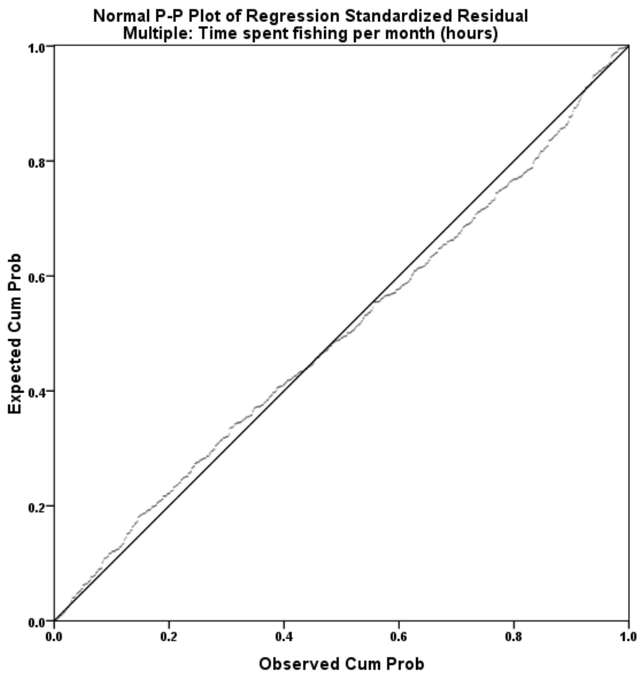

Cattle population
PACF
Lag Number
Upper Confidence Limit
Lower Confidence Limit
1.0
0.5
0.0
-0.5
-1.0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15
Lag Number

APPENDIX F: STANDARDIZED RESIDUAL PLOTS

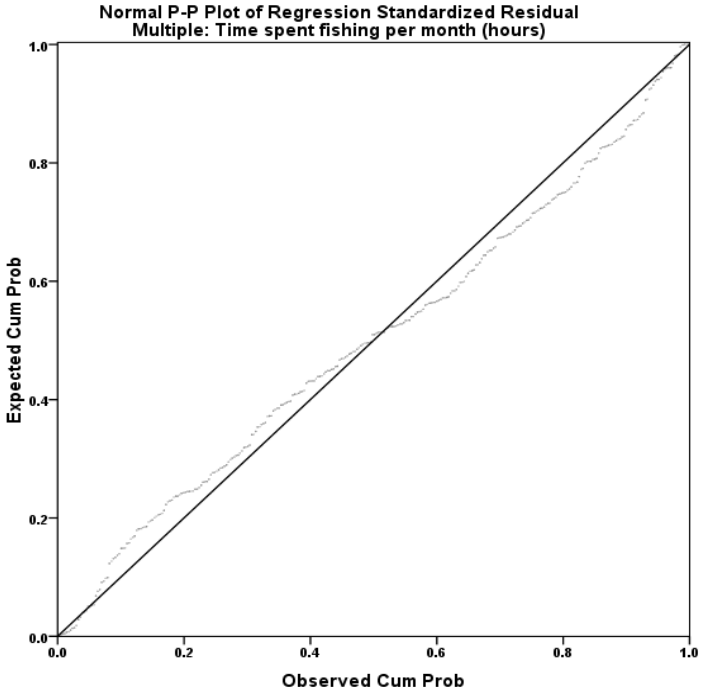
Appendix F1: Standardised residual plots of factors affecting time spent fishing in the Kafue floodplain, 2007/2008.



Above: Enter method. Below: Stepwise method



Appendix F2: Standardised residual plots of factors affecting time spent fishing in the Lower Shire floodplain, 2008.



Above: Enter method. Below: Stepwise method